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LABORATORY MANUAL
ON
AUTOMOBILE SERVICING AND MAINTENANCE

Contributors

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A P Verma

(Experimental edition)
1984

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Department of Vocationalization of Education
National Council of Educational Research and Training
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PREFACE

Ever since the introduction of vocationalization in our school system by several States in our country, the paucity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programme and a source of great hardship to students offering vocational studies at the higher secondary stage.

The Vocationalization of Education Unit of the National Council of Educational Research and Training has started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of vocational education. The task is too gigantic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by working group of experts constituted by NCERT.

The present manual is on 'Automobile Servicing and Maintenance' and is an important area in technology. It contains practical exercises to be performed by the students with simple steps to follow, precautions to be taken and data to be observed and recorded in observation sheet. Each experiment is complete with brief theoritical information, specific objectives, behavioural outcome, review questions etc. It is hoped that the students will find them immensely useful.

The pages that follow contain a draft of the writing which will be finalized after obtaining the responses and feed-back from students, teachers and others concerned. The materials will then be published in the printed form.

The users are requested to complete the questionnaire appended and return it to us. Comments and suggestions for improvement of the materials are also welcome.

The material has been developed by a group of experts as authors in a Workshop held at the NIE Campus, New Delhi. Their names are mentioned elsewhere and their contributions are considerably acknowledged. Shri A.P. Verma, Reader, V.E.U deserves special thanks for editing and bringing the material in the present form. The assistance of all the staff members of VEU and [illegible], NCERT is also thankfully acknowledged.

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New Delhi
October, 1983.

/TARA/

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- the teachers on the manual (1) -

- the pupils on the manual -

INTRODUCTION

The vocationalization of higher secondary education in the 10 + 2 pattern of schooling has been introduced by several States in the country. The implementation of this programme received further encouragement by the Conference of Education Ministers in 1981. With the priorities laid down in the 6th plan a few more States are seriously planning to switch over to 10 + 2 pattern of education and to implement vocationalization at the + 2 stage.

The implementation of the programme for the States has revealed that there a great dearth of appropriate instructional materials. Since the vocational courses laid a great emphasis on practical training it has become necessary to prepare instructional materials particularly suited for these courses. The absence of appropriate instructional material has been one of the major constraints in the implementation of the programme and a source of great hardship to pupils offering vocational studies at the higher secondary stages.

To develop models of instructional materials the Unit constituted a working group to formulate guidelines for the development of instructional materials for different areas, i.e., agriculture, commerce, home science, para-medical and technology. National guidelines were developed by this working group for the preparation of instructional materials.

The present manual is on "Automobile servicing and maintenance" which is an important area of technology. This manual is envisaged to help both teachers and students. In the manual a large number of diagrams are given to explain the various components and their relative [illegible]. For each experiment the general objective, specific objective, introduction, procedure, tools required assembly and dis-assembly, precautions, review questions, observation sheet etc. have been given. In order to acquaint the pupils about each experiment the teachers should provide them with required theoretical knowledge or information relevant to the experiment. This will help the pupil for proper understanding of the experiment and enable them to perform the experiment properly and [illegible] develop the necessary psycho-motor skills. In other words, 'what' and 'why' part of each experiment should be explained well in advance by the teacher.

The evaluation of the experiments performed by the students, by and large, shall be based on the specific objectives. The teacher shall evaluate all those aspects which are relevant to achieve the specific objectives. This will become part of the expected behavioural outcome. The evaluation is made up of the following components and break up of marks.

Components	Marks	Marks Obtained
Knowledge	20	
acquired skills	40	
attitude of learner	10	
interest and self-confidence	10	
application	10	
acceptability	10	
Total :	100	

At the end of each experiment some review questions related to the experiment are also given. The student shall write appropriate answers after the completion of each experiment and the teacher shall examine them. If required suitable conclusions and suggestions can be incorporated by the teacher. However, the answers to those questions should not be considered for the purpose of evaluation.

Automobile Servicing and Maintenance

Servicing automobiles is a very important area of business. With a large number of cars, scooters etc. running millions of miles a year a tremendous amount of service is needed. By service we mean periodic checking of all the various parts of the vehicle, making adjustments to the different mechanisms when necessary, replacing parts when they wear out, and, in general, restoring new car performance.

This service work requires a great variety of activities. Sometimes it may simply mean the turning of a nut or screw. Or it may be as simple as taking the battery caps off to give the battery some water. On the other hand it may require removal of bolts so that parts can be lifted off and internal mechanisms exposed. Then, these internal parts can be adjusted, repaired or replaced.

In the pages that follow, all the mechanisms on the automobile, from the engine, transmission and differential etc. have been discussed. The various systems like ignition system, fuel system, braking system, transmission system etc. have been studied and it has been explained how these systems could be serviced.

Experiment No. 1.1.

General Objective: Study of Engine Parts.

Specific Objectives:

(1) To know the constructional features of a four stroke, Four cylinder, water cooled, In-line type, Over head valve, Force-Feed Lubricated, Petrol Engine.

(2) To know the various stationary components, their materials and purpose/function

(3) To know the various moving components, their materials and purpose/function.

Introduction

The Engine is a power unit for the automobile. This unit converts chemical energy of the fuel into mechanical energy. To achieve this, fuel is burnt inside the cylinder by allowing it to mix in correct proportions in a device called carburettor. The initiation of the combustion is done by providing a spark at the spark plug, at the correct time. The cylinder is having one end closed and on the other side is having a moving plug, the so called piston. The liberation of heat energy is done on top of the piston which provides pressure on it.

The piston along with connecting rod crankshaft and flywheel forms a system which will convert the pressure energy on top of the piston into the mechanical energy available at the Fly wheel. To have efficient functioning of the engine, it is provided with AIR/ Fuel system, ignition system, Exhaust system, Lubricating oil system, and water cooling system. The whole unit will have many components, stationary as well as moving, these are described below:-

List of Major Engine Components - Moving.

S.No.	Component	Material	Purpose
1.	Piston	Aluminium-Silicon-Alloy	To work as a moving plug for the conversion of chemical energy of fuel into mechanical energy.
2.	Piston Rings.	Cast Iron.	(i) To prevent leakage of high pressure gases past the piston (ii) To prevent lubricating oil from entering into the combustion chamber. (iii) To reduce the bearing surface area of the piston against the cylinder wall.

3.	Gudgeon pin. (wrist pin or piston pin)	Alloy steel.	To provide a bearing connection between the piston and the connecting rod.
4.	Circlips	Spring steel	To hold the gudgeon pin in its place.
5.	Connecting Rod (having a small end and a big end)	Forged steel	To convert reciprocating [illegible] motion.
6.	Crank-shaft consisting of	(i) Alloy steel (Forged)	[illegible]
(a)	Crank Pin		To provide journal for [illegible] connecting rod.
(b)	Main Journal		To provide journal for [illegible] cylinder [illegible].
(c)	Crank-web	Alloy steel (Forged)	[illegible]
7.	Flywheel	(i) Cast Iron (ii) Cast Steel	To balance the cyclic fluctuations [illegible] by storing energy when it is in excess and releasing it when required.

8. Crankshaft Pulley		To provide belt drive to the cooling fan, cooling water pump, and dynamo.
9. Timing Gear.	(i) Fibre (ii) Alloy Steel (iii) Cast Steel	To drive cam shaft at half of the crankshaft speed.
10. Camshaft consisting of	Forged steel	
(i) Cam		(i) To operate valves
(ii) Journals		(ii) To provide surfaces for the cam-shaft bearings
(iii) Eccentric		(iii) To operate lubricating oil pump
(iv) Gear		(iv) To provide motion to the distributor shaft.
11. Tappets	Steel	To convert the rotary motion of the cam into reciprocating motion of push rod.
12. Push Rod.	Steel	To operate the rocker arm
13. Rocker Arm	Forged Steel	To open the valves.
14. Valves	Alloy Steel	To control the inflow of charge and out flow of the exhaust gases.

LIST OF MAJOR ENGINE COMPONENTS - STATIONARY

No.	Components	Material	Purpose
1	2	3	4
1.	Cylinder Block	Grey Cast Iron	Provides housing for (a) the oil gallery (b) water jackets, (c) for crankshaft, (d) cam shaft, (e) distributor, (f) oil pump. To provide cylinder for pistons. To provide the positioning of timing sprockets with cover, water pump, fan pulley, bracket for dynamo, starting motor holes for tappets and push rods. House for water drain plug bore for oil seals at the crank-shaft positions. Threaded holes for connecting oil sump, for assembly of the cylinder head, clutch assembly etc. and timing cover.
2.	Cylinder head	Grey cast Iron or Alluminium alloy.	It has provision for the Exhaust and Inlet ports, arrangement to hold Valve Assemblies and mountings

			for Rocker shaft brackets, holes for spark plugs and Push Rods. Housing for water jackets, connection for inlet and exhaust manifolds, combustion chambers, provision for water outlet. Seatings for the exhaust and inlet valves. Threaded holes for tappet cover.
3.	Exhaust Manifold	Cast Iron	It has provision for collection of exhaust gases, bend pipe and further connections.
4.	Inlet Manifold	Cast Iron	It has mounting for the carburetter bend pipe to distribute air-fuel mixture to cylinders at the inlets.
5.	Oil Sump	Pressed Steel or Alluminium Alloy	It is a reservoir for the lubricating oil required for forced-feed lubrication of the engine, It is fitted at the bottom of the cylinder block, and has a threaded hole to fix magnetic drain plug.

6.	Valve Guide	Grey Cast Iron, Mild Steel.	Provides guide for the motion for the valve stem.
7.	Water Pump Body	Grey Cast Iron, Alluminium Alloy	It has connection with cylinder block housing for the pump impeller and bearings. It has connection for the water inlet from the radiator.
8.	Oil Pump Body	Alluminium Body	Provides housing for the rotors/gears. It has provision for inlet of the lubricating oil, connection for the inlet pipe from the oil strainer, and mounts the oil pump shaft tube.
9.	Timing chain Cover	Pressed Steel	It provides cover to the timing Gears/chain and sprockets from dust and dirt. Protects the oil from spilling out. Has provision to assemble oil seal.
10.	Tappet Cover	M.S.Sheet	It provides cover for the rockers, pillars, valves, push rods to safeguard them from dust and spilling of oil. It has provision for the filling of the lubricating oil.

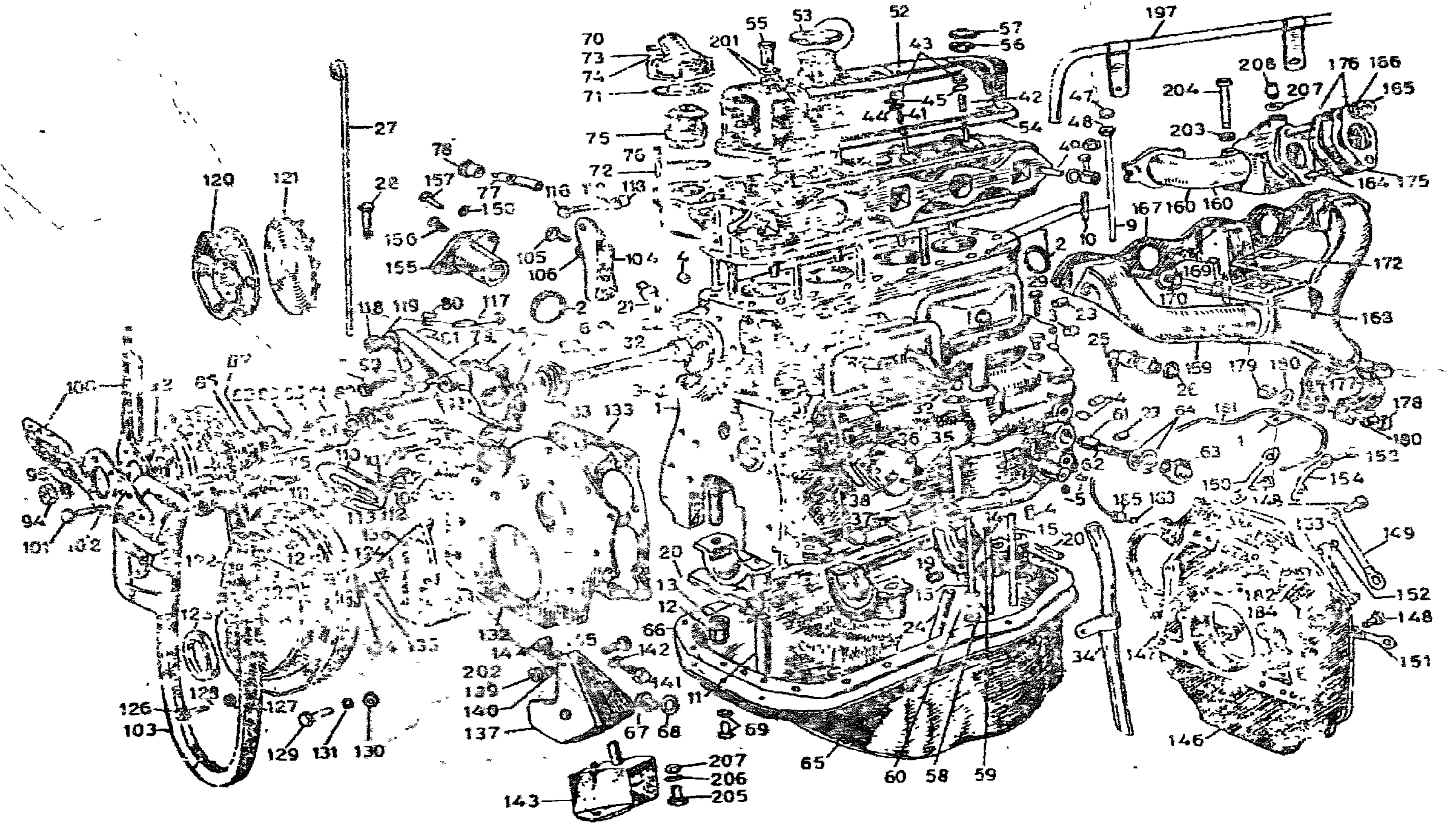
			It has provision for the crank case breather.
11.	Tappet side plate	M.S. Sheet	It provides cover for the inspection of the push rods and tappets.
12.	Front and Rear Mounting Plates	Steel Plate	Front plate is there to provide fixing arrangements for timing cover and the rear plate is provided to have provision for connecting the bell housing of the clutch
13.	Crankshaft - Main journal Caps	Forged steel, Cast Iron	It provides bearing surfaces for the main journal of the crankshaft. It facilitates the dis-assembly of the crankshaft.
14.	Cylinder (part of the cylinder block at Sr. No. 1)	Grey Cast Iron	It has a smooth bearing surface for the piston, piston rings, and serves as a guide for the piston.
15.	Water Outlet (Elbow)	Alluminium Alloy or C.I.	It is a mounting.
16.	Oil Filter Body & cover	Sheet Metal	It houses the lubricating oil filter. Provides inlet and outlet of the lubricating oil.

17.	Cylinder Head Gaskets	Copper Clad -asbestos-	It provides a leak-proof joint between the cylinder head and block under pressurised condition.
18.	Inlet and Exhaust manifold gasket	Metal Impregnated asbestos	To obtain leak-proof joint of the manifolds at the inlet and exhaust ports. To provide flexibility at the exhaust valve ports for the thermal expansion of the exhaust manifold.
19.	Tappet side cover packing and sump packing, rocker cover packing, Timing gear cover packing.	Cork	All are essential to prevent leakages.
20.	Water Pump Body Packing oil, fuel, pump body packing.	Hylite Sheet or Oil Paper	- do -
21.	Oil Filler Cap	Pressed Sheet Metal	It provides the cover to the lubricating oil filling hole on the tappet cover and to inspect the leakages of the gases into the crank case.
22.	Dipstick for oil checking.	Alloy Steel	A measuring stick to check the lubricating oil in the oil sump.
23.	Core plug hole cap for cylinder block	Steel Disc.	It seals the holes drilled for the removal of the cores.

Evaluation

1. Why is cam shaft rotated at half the speed of crankshaft
2. Why is cooling system provided?
3. Why is lubrication system provided?
4. How is the cylinder wall lubricated?
5. Why is force feed lubrication needed?
6. How is the small end bearing lubricated?
7. How is big end bearing lubricated?
8. Why are piston rings required?
9. Why is crank-case breather provided?
10. What will happen to the engine if wrong grade of lubricating oil is used in it?
11. Why are the sizes of the journals provided on the camshaft different?
12. Why is a relief valve required in the lubricating oil circuit?
13. Why are two compartments provided in the oil sump?
14. Why is the lubricating oil drain plug magnetic?
15. What is the difference between the inlet and exhaust valves?
16. Why are the cams not allowed to touch exactly at the middle surface of the tappets?
17. How is the life of the engine affected if the air cleaner is removed.
18. What is the function of the springs provided on the val

FIG. 1·1 - THE ENGINE COMPONENTS



19. What is the speed of Distributor shaft in comparison to cam shaft?
20. Why are pistons generally made of Aluminium alloy?
21. What will be the effect of fitting a wrong sized head gasket?

PRECAUTIONS

1. Always use correct types and sizes of spanners for dis-assembly and assembly of the engine.
2. Use the correct sequence while dis-assembling and reverse the sequence while assembling the engine.
3. Correct sequence should be observed while tightening the cap nuts of crankshaft bearings as well as cylinder head.
4. Use the recommended grade of oil for the engine for summer and winter seasons.
5. Tighten all the nuts to their recommended torques
6. Cleanliness should be maintained while matching and setting the various clearances.

Experiment No. 2.1

General Objective : Study of Ignition System

Specific Objectives :

1) To know the working of battery ignition system.
2) To know the working of magneto ignition system;

INTRODUCTION :

The ignition System is a part of the electrical system of the petrol engine driven Automibile. Its purpose is to produce a high voltage surge (of upto 20,000 volts) and deliver them to the combustion chamber in the engine. These high voltage surges then cause electric sparks in the combustion chambers. The sparks ignite, or set fire, to the air fuel mixture in combustion chamber so that it burns and causes the engine to operate. For best engine performance it is essential to have an accurately timed spark i.e. approximimately 6 to 10 degrees before top dead centre (T.D.C.) at the time of starting the engine. As speed increases there should be provision to advance the spark timing, which is provided by the advancing mechanism fitted in the distributor.

There are two types of Ignition Systems adopted in petrol engines of two stroke and four stroke categories. In multicylinder 4 stroke cycle, petrol engines fitted in cars, jeeps etc. the Battery Ignition System is commonl

3.	Gudgeon pin. (wrist pin or piston pin)	Alloy steel.	To provide a bearing connection between the piston and the connecting rod.
4.	Circlips	Spring steel	To hold the gudgeon pin in its place.
5.	Connecting Rod (having a small end and a big end)	Forged steel	To convert reciprocating motion of the piston to rotary motion of the crankshaft.
6.	Crank-shaft consisting of	(i) Alloy steel (Forged)	To transmit rotational energy to the flywheel.
(a)	Crank Pin		To provide journal for the big-end bearing of the connecting rod.
(b)	Main Journal		To provide journal for the main bearing of the cylinder block.
(c)	Crank-web	Alloy steel (Forged)	To balance the unbalanced forces.
7.	Flywheel	(i) Cast Iron (ii) Cast Steel	To balance the cyclic fluctuation of the speed by storing energy when it is in excess and releasing it when required.

8.	Crankshaft Pulley		To provide belt drive to the cooling fan, cooling water pump, and dynamo.
9.	Timing Gear.	(i) Fibre (ii) Alloy Steel (iii) Cast Steel	To drive cam shaft at half of the crankshaft speed.
10.	Camshaft consisting of	Forged steel	
	(i) Cam		(i) To operate valves
	(ii) Journals		(ii) To provide surfaces for the cam-shaft bearings
	(iii) Eccentric		(iii) To operate lubricating oil pump
	(iv) Gear		(iv) To provide motion to the distributor shaft.
11.	Tappets	Steel	To convert the rotary motion of the cam into reciprocating motion of push rod.
12.	Push Rod.	Steel	To operate the rocker arm
13.	Rocker Arm	Forged Steel	To open the valves.
14.	Valves	Alloy Steel	To control the inflow of charge and out flow of the exhaust gases.

LIST OF MAJOR ENGINE COMPONENTS - STATIONARY

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2.	Cylinder head	Grey cast Iron or Alluminium alloy.	It has provision for the Exhaust and Inlet ports, arrangement to hold Valve Assemblies and mountings

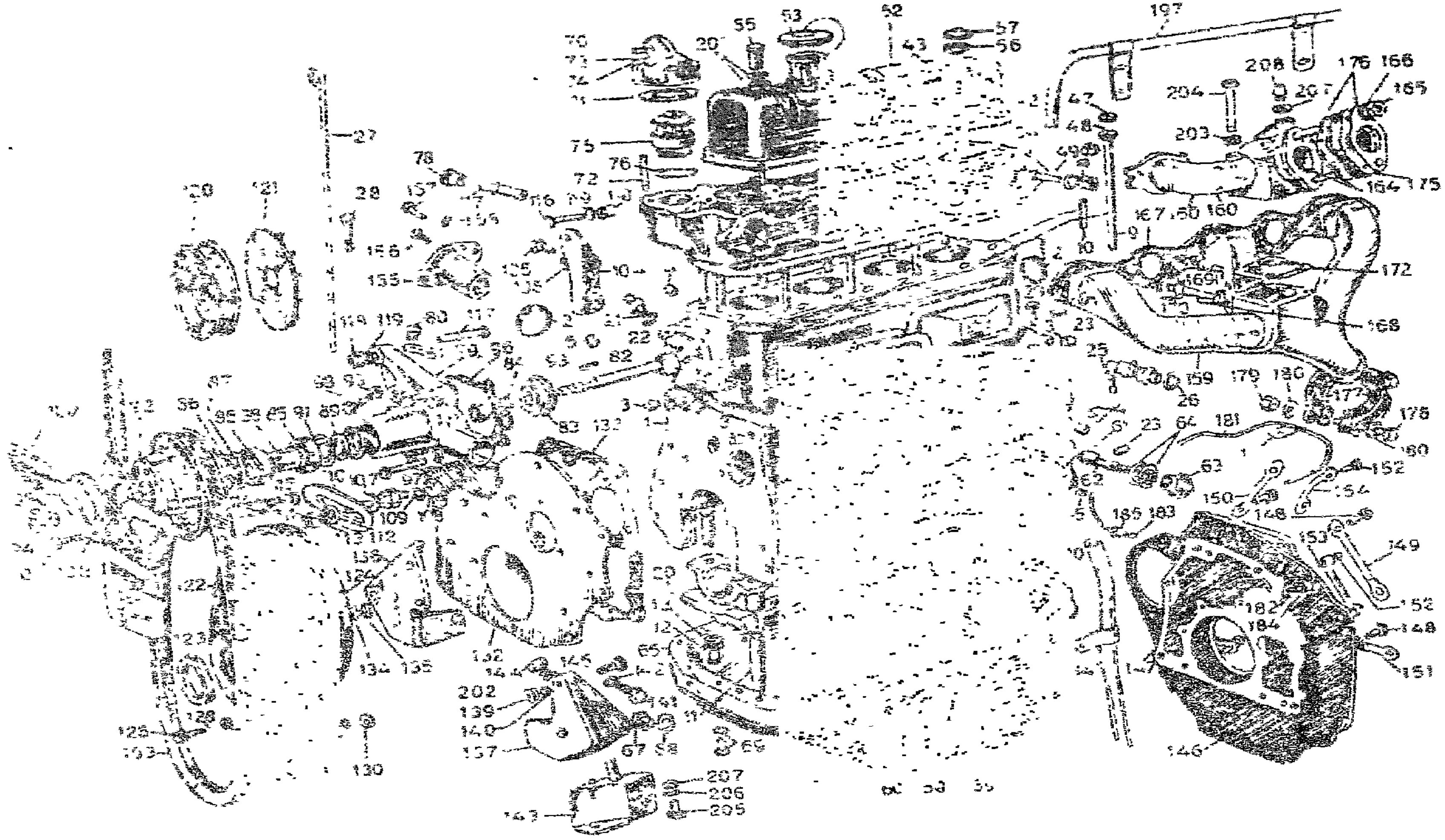
			for Rocker shaft brackets, holes for spark plugs and Push Rods. Housing for water jackets, connection for inlet and exhaust manifolds, combustion chambers, provision for water outlet. Seatings for the exhaust and inlet valves. Threaded holes for tappet cover.
3.	Exhaust Manifold	Cast Iron	It has provision for collection of exhaust gases, bend pipe and further connections.
4.	Inlet Manifold	Cast Iron	It has mounting for the carburetter bend pipe to distribute air-fuel mixture to cylinders at the inlets.
5.	Oil Sump	Pressed Steel or Alluminium Alloy	It is a reservoir for the lubricating oil required for forced-feed lubrication of the engine, It is fitted at the bottom of the cylinder block, and has a threaded hole to fix magnetic drain plug.

6.	Valve Guide	Grey Cast Iron, Mild Steel.	Provides guide for the motion for the valve stem.
7.	Water Pump Body	Grey Cast Iron, Alluminium Alloy	It has connection with cylinder block housing for the pump impeller and bearings. It has connection for the water inlet from the radiator.
8.	Oil Pump Body	Alluminium Body	Provides housing for the rotors/gears. It has provision for inlet of the lubricating oil, connection for the inlet pipe from the oil strainer, and mounts the oil pump shaft tube.
9.	Timing chain Cover	Pressed Steel	It provides cover to the timing Gears/chain and sprockets from dust and dirt. Protects the oil from spilling out. Has provision to assemble oil seal.
10.	Tappet Cover	M.S.Sheet	It provides cover for the rockers, pillars, valves, push rods to safeguard them from dust and spilling of oil. It has provision for the filling of the lubricating oil.

			It has provision for the crank case breather.
11.	Tappet side plate	M.S. Sheet	It provides cover for the inspection of the push rods and tappets.
12.	Front and Rear Mounting Plates	Steel Plate	Front plate is there to provide fixing arrangements for timing cover and the rear plate is provided to have provision for connecting the bell housing of the clutch.
13.	Crankshaft - Main journal Caps	Forged steel, Cast Iron	It provides bearing surfaces for the main journal of the crankshaft. It facilitates the dis-assembly of the crankshaft.
14.	Cylinder (part of the cylinder block at Sr. No. 1)	Grey Cast Iron	It has a smooth bearing surface for the piston, piston rings, and serves as a guide for the piston.
15.	Water Outlet (Elbow)	Alluminium Alloy or C.I.	It is a mounting.
16.	Oil Filter Body & cover	Sheet Metal	It houses the lubricating oil filter. Provides inlet and outlet of the lubricating oil.

17.	Cylinder Head Gaskets	Copper Clad -asbestos-	It provides a leak-proof joint between the cylinder head and block under pressurised condition.
18.	Inlet and Exhaust manifold gasket	Metal Impregnated asbestos	To obtain leak-proof joint of the manifolds at the inlet and exhaust ports. To provide flexibility at the exhaust valve ports for the thermal expansion of the exhaust manifold.
19.	Tappet side cover packing and sump packing, rocker cover packing, Timing gear cover packing.	Cork	All are essential to prevent leakages.
20.	Water Pump Body Packing, oil, fuel, pump body packing.	Holite Sheet or Oil Paper	- do -
21.	Oil Filler Cap	Pressed Sheet Metal	It provides the cover to the lubricating oil filling hole on the tappet cover and to inspect the leakages of the gases into the crank case.
22.	Dipstick for oil checking.	Alloy Steel	A measuring stick to check the lubricating oil in the oil sump.
23.	Core plug hole cap for cylinder block	Steel Disc.	It seals the holes drilled for the removal of the cores.

FIG.-1-1 - THE ENGINE COMPONENTS



KEY TO THE ENGINE COMPONENTS

[illegible]

[illegible] of main casting

[illegible]

lever

[illegible]

—block side.

[illegible]—front [illegible]

[illegible]

p—cylinder block vent

k plate [illegible]—L.H.

ock.

ring—screw.

ac.

le.

—rocker bracket

rocker bracket.

et stud

acket stud.

ring—bracket stud.

er head stud.

linder head stud.

ust manifold.

[illegible]

73. Nut—stud.
74. Washer—stud.
75. Thermostat.
76. Joint.
77. Thermal transmitter.
78. Gland nut.
79. Body—water pump
80. Plug—body of water [illegible]
81. Washer—plug
82. Spindle with vane
83. Seal—oil
84. Distance piece.
85. Bearing
86. Circlip.
87. Retainer—grease.
88. Distance piece—bearing.
89. Felt.
90. Retainer—felt—inner.
91. Retainer—felt—outer.
92. Pulley.
93. Key—pulley.
94. Nut—spindle.
95. Washer—spring—spindle nut.
96. Joint—to block.
97. Screw—long—to block.
98. Screw—short—to block.

[illegible]

117. Bolt—dynamo to water pump body
118. [illegible]—bolt.
119. Washer—spring—bolt.
120. Pulley
121. Fan—dynamo.
122. Cover—front—cylinder block
123. Felt
124. Joint—to front mounting plate
125. Screw—to mounting plate
126. Screw.
127. Washer—screw
128. Washer—spring—screw
129. Screw
130. Washer—screw
131. Washer—spring—screw.
132. Plate—front mounting.
133. Joint—to block.
134. Screw—to block
135. Washer—spring—screw
136. Bracket—front mounting—R/H.
137. Bracket—front mounting—L.H.
138. Bolt—to plate
139. Nut—bolt.
140. Washer—spring—bolt
141. Screw—to block.
142. Washer—spring—screw.
143. Rubber—front mounting.

[illegible]

155. Housing—distributor
156. Screw—to [illegible]
157. Screw—distributor to housing
158. Washer—spring—screw
159. Manifold—exhaust.
160. Manifold—induction.
164. Stud—carburetter
165. Nut—stud
166. Washer—spring—stud
167. Joint—manifold to head
168. Screw—clamping
169. Washer—spring—screw
170. Washer—clamping.
172. Joint—inlet to exhaust
175. Distance piece
176. Joint—carburetter to manifold.
177. Clamp—to manifold
178. Bolt—clamp
179. Nut—bolt
180. Washer—bolt.
181. Pipe—ignition control
182. Nipple—carburetter end
183. Olive—distributor end
184. Tube nut—carburetter end
185. Tube nut—distributor end.
186. Clip—to cylinder head
197. Pipe—short hose to radiator.
201. Washer—nut.
202. Washer—front bracket
203. Washer—inlet to exhaust screw
204. Screw—inlet to exhaust.
205. Bolt—to frame
206. Washer—spring—bolt.
207. Nut—bolt
208. Plug—blanking
209. Washer—plug

19. What is the speed of Distributor shaft in comparison to cam shaft?
20. Why are pistons generally made of Aluminium alloy?
21. What will be the effect of fitting a wrong sized head gasket?

PRECAUTIONS

1. Always use correct types and sizes of spanners for dis-assembly and assembly of the engine.
2. Use the correct sequence while dis-assembling and reverse the sequence while assembling the engine.
3. Correct sequence should be observed while tightening the cap nuts of crankshaft bearings as well as cylinder head.
4. Use the recommended grade of oil for the engine for summer and winter seasons.
5. Tighten all the nuts to the recommended torques
6. Cleanliness should be maintained while matching and setting the various clearances.

Experiment No. 2.1

General Objective : Study of Ignition System

Specific Objectives :

1) To know the working of battery ignition system.

2) To know the working of magneto ignition system;

INTRODUCTION :

The ignition System is a part of the electrical system of the petrol engine driven Automibile. Its purpose is to produce a high voltage surge (of upto 20,000 volts) and deliver them to the combustion chamber in the engine. These high voltage surges then cause electric sparks in the combustion chambers. The sparks ignite, or set fire, to the air fuel mixture in combustion chamber so that it burns and causes the engine to operate. For best engine performance it is essential to have an accurately timed spark i.e. approximimately 6 to 10 degrees before top dead centre (T.D.C.) at the time of starting the engine. As speed increases there should be provision to advance the spark timing, which is provided by the advancing mechanism fitted in the distributor.

There are two types of Ignition Systems adopted in petrol engines of two stroke and four stroke categories. In multicylinder 4 stroke cycle, petrol engines fitted in cars, jeeps etc. the Battery Ignition System is commonly used. In single cylinder two stroke cycle petrol engine which is generally fitted in Mopeds, scooters, and motor cycles the magneto ignition system is used.

Firing order and Firing Interval

Firing Order:- In a multicylinder engine, the various cylinders will fire their charge in a particular order. Thus in a 4 cylinder engine, the firing order most popularly followed is 1-3-4-2. This means, first, the cylinder number one will fire then cylinder number 3, then cylinder number 4 and then cylinder number 2. A 6-cylinder engine has a firing order 1-5-3-6-2-4.

Firing Interval: The 4 stroke cycle engine cylinder will fire once in every two flywheel revolutions. This interval between successive firing is called Firing Interval. Thus a single cylinder engine has a firing interval of 720 degress A two cylinder engine has an interval of 360 degrees; a three cylinder engine 240 degrees, a four cylinder engine 180 degrees and a six cylinder engine 120 degrees.

In general, the firing internal of a 4 stroke cycle engine is 720/N where N is the number of cylinders. A single cylinder 2 stroke cycle engine will fire once in one revolution i.e. 360 degrees. Thus the firing interval of a single cylinder 2 stroke cycle engine is 360 degrees, that of a two cylinder, engine 180 degrees. In general the firing interval of a two stroke cycle engine is 360/N where N is the number of cylinders.

Battery Ignition System :- 4 stroke cycle-petrol engine.

(Refer Fig No. 2.1.1. & 2.1.2.)

Components/parts:

1) Battery
2) Ignition Switch
3) Low Tension wire

Ignition Coil
4) Primary winding
5) Secondary winding
6) Soft-iron core

7) High Tension wire
8) Capacitor/Condenser

Distributor Unit
9) Contact Breaker
10) Cam
11) Contact Braker Points (C.B.Points)
12) Rotor Arm

13) Distribitor Cap
14) Spark plug

Magneto Ignition System - Two stroke petrol engine Fig 2.1.3

Components/Parts

1. Permanent horse shoe magnet
2. Ignition Switch
3. Low tension wire
4. Primary coil

5. Secondary coil
6. Soft iron core
7. High Tension wire
8. Capacitor/Condensor
9. Contact Breaker
10. Cam
11. C.B. Points
12. Spark plug

Equipment - Tools:

1) 2 stroke cycle engine of a motor cycle or moped or Scooter.
2) 4 stroke cycle petrol engine of a car or a jeep.
3) Cut section models of 2 stroke cycle petrol engine.
4) Cut section models of 4 stroke cycle petrol engine.
5) Charts showing Ignition Circuits.
6) General hand tools - spanner sets
   - screw driver etc.

PROCEDURE

Battery Ignition System

S.No.	Name of the part/ component	material/ compostion if it is an alloy	Purpose	Remarks
1	2	3	4	5
1.	Battery	Details given in Battery	-	-
2.	Ignition Switch	Bakelite	To make the circuit or break the circuit	-
3.	Low Tension wire	Copper	To pass the low tension current	-
4.	High Tension wire	Copper	To pass the high tension current	-
5.	Secondary winding of Ignition coil	Copper	To step up the voltage	The secondary winding has several thousand turns of this wire and one of the ends is connected to primary winding
6.	Primary winding of Ignition coil	Copper	To produce magnetic flux in the soft-iron core	Has few turns of thick wire
7.	Soft-iron core	Soft-iron	It is used to concentrate the magnetic flux	Varnished

8.	Capacitor/ condensor	Aluminium foil as electrodes	It increases the back e.m.f. in the primary circuit. It helps reduce the sparking across the contact breaker points.	Parallel Plate paper condenser capacity 0.2 Micro farad
9.	Contact Breaker	Steel	To open and close the primary circuit	-
10.	Cam.	Alloy Steel	To operate the contact breaker	Number of lobes equals the number of cylinder
11.	Contact Breaker points (C.B. Points)	Tungsten	Makes and breaks the flow of current in primary winding	-
12.	Rotor Arm	Copper	To pass high voltage current to spark plug line	-
13.	Distributor cap	Hardened.	To hold the electrodes	-
14.	Spark plug	Details are given in Chapter, on Spark Plug.		

Procedure

Magneto Ignition System   Refer Fig. 2.1.3

S.No.	Name of the part	Name of the Material	Purpose	Remarks
1.	Magneto Unit (Permanent Magent)	Steel - Aluminium-nickel-cobalt Alloy	To step up high voltage	1) Scooter & Motor Cycle : The Magent is rotated
2.	Switch	Bakelite	To make and break the circuit	---------
3.	Ignition coil	Copper Alloy	To set up the high voltage	---------
4.	Other components same as for Battery Ignition System.			---------

Observation Sheet

(Battery Ignition system)

S. No.	Name of the part/component	Material/components if it is alloy	Puposе	Colour	Remarks

OBSERVATION SHEET

Magneto Ignition System

S.No.	Name of the part	Name of the material	Purpose [illegible]	Remarks

EVALUATION SHEET

1. The firing order of 4 stroke cycle - 4 cylinder is

_______________ a) 1,2,3,4 b) 4,3,2,1

c) 1,3,4,2 d) none of the above.

2. In Battery Ignition System the Magneto is used:

True / False

3. The Bullet 350 cc is the best example of 4 stroke single cylindet engine.

True / False

4. In High Tension coil the voltage produced is_______________

a) 1000 v b) 1,00,000 v c) 20,000 v

d) 50,000 v

5. The condenser is connected across the_______________

a) cam b) battery c) distributor d) dontact breaker points.

6. The gap is too wide in the contact breaker point.

True / False

7. The gap of the contact breaker point is__________

8. Gap spark plug is more/less than the gap at C.B.Points.

9. The firing interval in 4 stroke cycle single cylinder is

a) 720° b) 360° c) 180° d) 120°

REVIEW QUESTIONS

A. IDENTIFY THE TRUTH OF FOLLOWING STATEMENTS

1. Bus Cars adopt Battery Coil Ingition System T/F
2. Low-Tension Conductor is used in Secondary Winding T/F
3. Condenser Connected in the Primary Circuit T/F
4. C.B.Points are connected in the Secondary Circuit T/F
5. Secondary Voltage in the Ignition Coil in the order of 20,000 volts
6. Secondary Wire is thicker then the Primary wire T/F
7. Secondary Voltage is developed when the C.B.Points open t/F
8. Gap between the spark plug electrodes allow the high tension spark to jump across T/F
9. Fouled Spark plugs will lead to mis-firing of cylinders T/F
10. The Firing Interval in a 4 cylinder 4 stroke cycle Engine is 120^{0} T/F
11. The Firing Interval in a single cylinder 4 stroke cycle Engine is 360^{0}
12. The Firing Interval in a 6 cylinder 4 stroke cycle Engine is 120^{0} T/F
13. The common firing order for a 6 cylinder Engine is 153624 T/F

14. Ignition of the Working charge is done at the end of Suction stroke T/F

15. When the Ignition Coil is very hot it will give a weak spark T/F

16. Less Capacity condensor will pit the C.B.Points T/F

B. FILL UP THE BLANKS : WITH SUITABLE VALUES/WORDS

1. When 3 Lead Acid Cells are connected in series the total voltage of the Battery is ________

2. When 2, 12-Volt Batteries are connected in parallel the total voltage of the combination is ________

3. The effective material of positive plate in lead acid Battery is ________

4. ________ Acid is used as the Electrolyte in lead acid Batteries.

5. Distilled water is poured to ________ level of Electrolyte in cell.

6. Hydrometer is used to test the ________ of the Electrolyte.

7. Cell Tester is used to test the ________ of the Cell.

8. The Gap between the Electodes of the spark plug is ________

9. The Gap between the contact Breaker Points is ________

10. The firing order in case of Premier/Ambassador Car Engines is ________

11. Ignition Timing of the Engine Corresponds to No. 1 cylinder's piston at ________ position.

12. As the Engine speed increases the Ignition timing should be ____________ __________.

13. The capacity of condensor is measured in ________________.

14. In Scooters _____________ Ignition system is adopted.

15. Recommended Life of spark plugs in 4 stroke cycle petrol Engines is _____________ _____ Kilometres.

16. Recommended Life of spark plugs in 2 stroke cycle petrol Engine is ____________________ Kilometres.

Ignition System

Answer

To questions on evaluation sheet.

1. c
2. False
3. True
4. C
5. d
6. False
7. 0.6 mm.
8. More
9. a

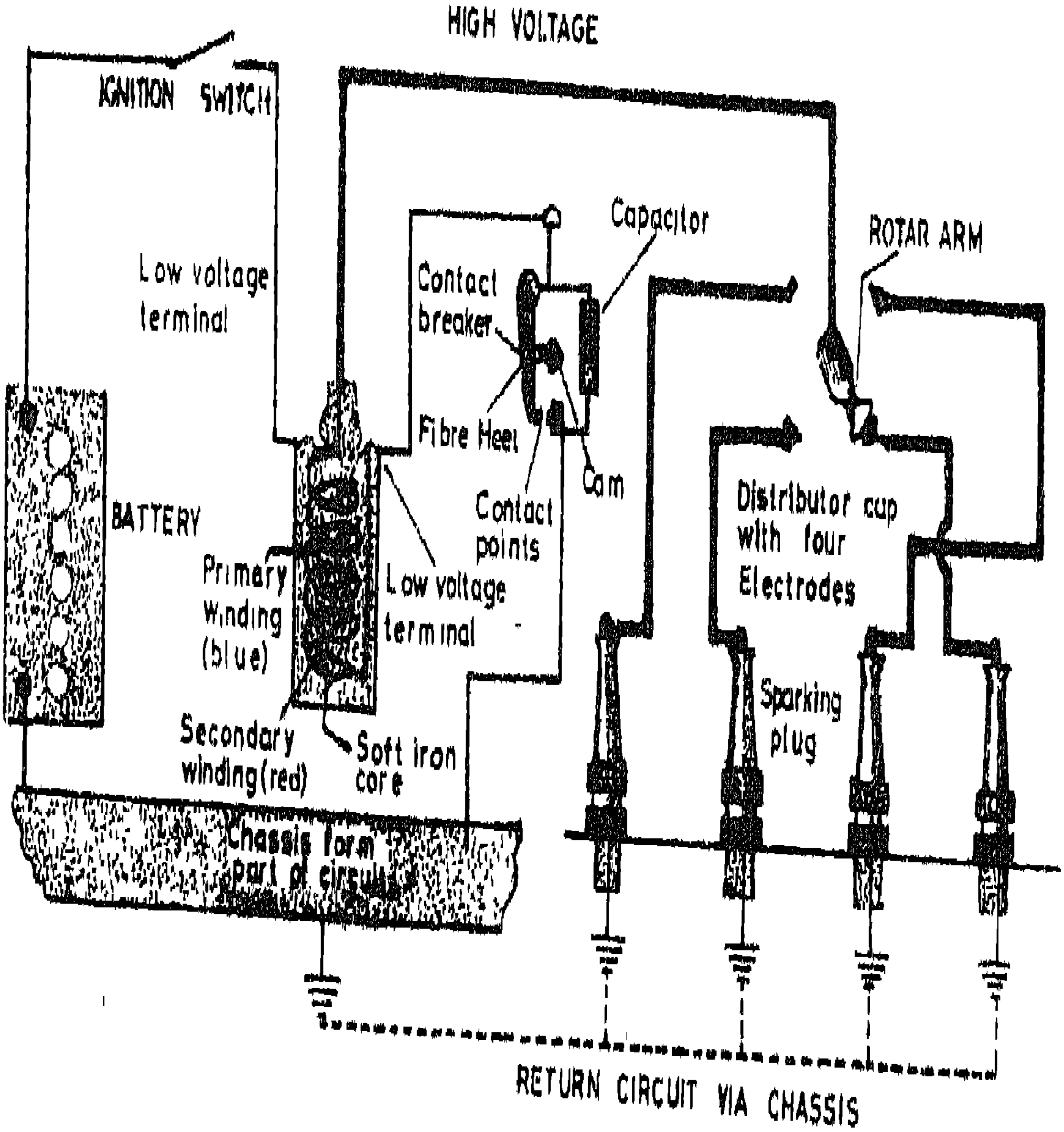


FIG. 2.1.1 BATTERY IGNITION SYSTEM (WIRING DIAGRAM)

FIG.- 2·1·2 - SIMPLIFIED PICTURE OF THE LOW TENSION (LOW VOLTAGE) PART OF THE IGNITION SYSTEM

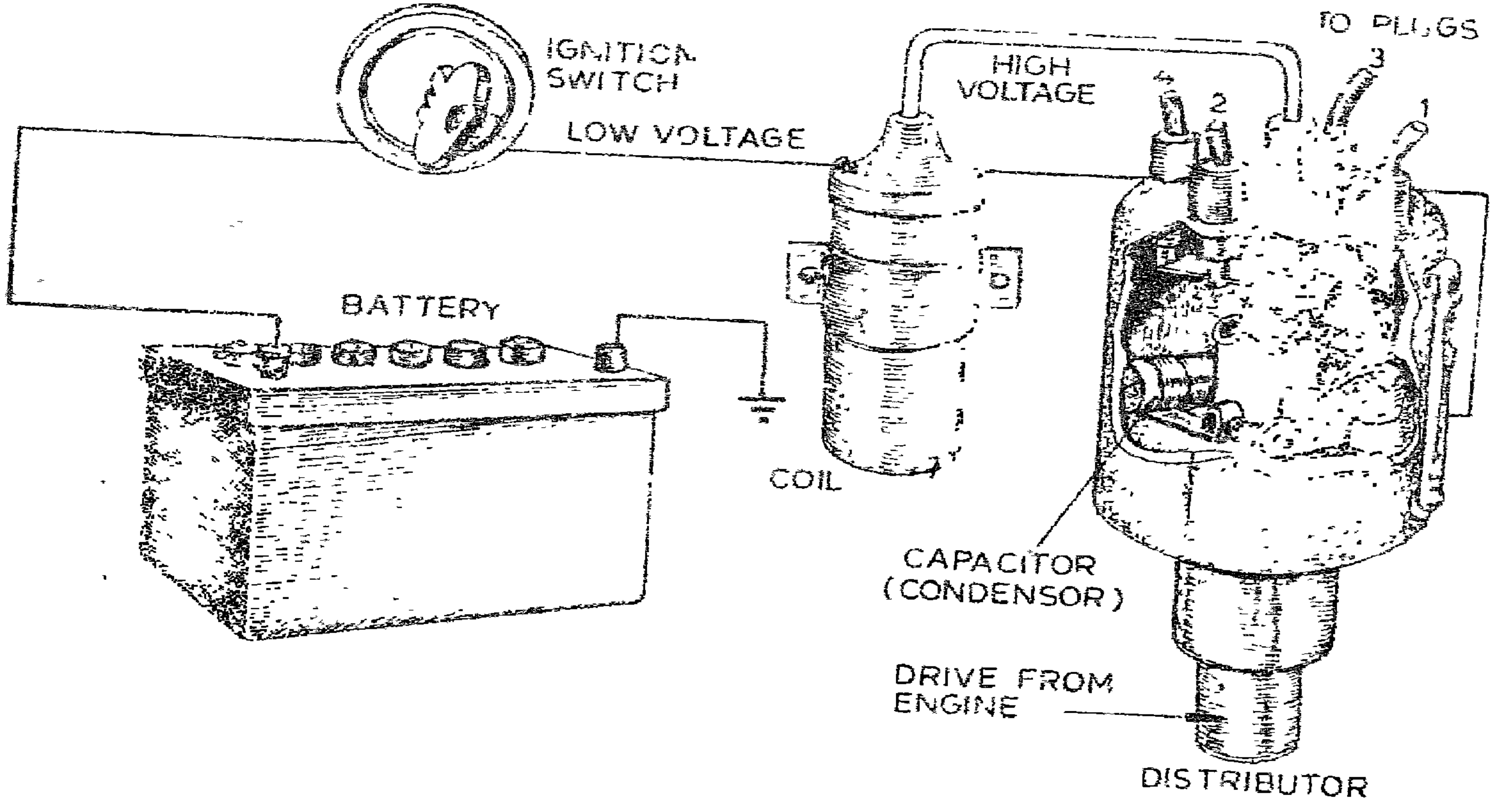
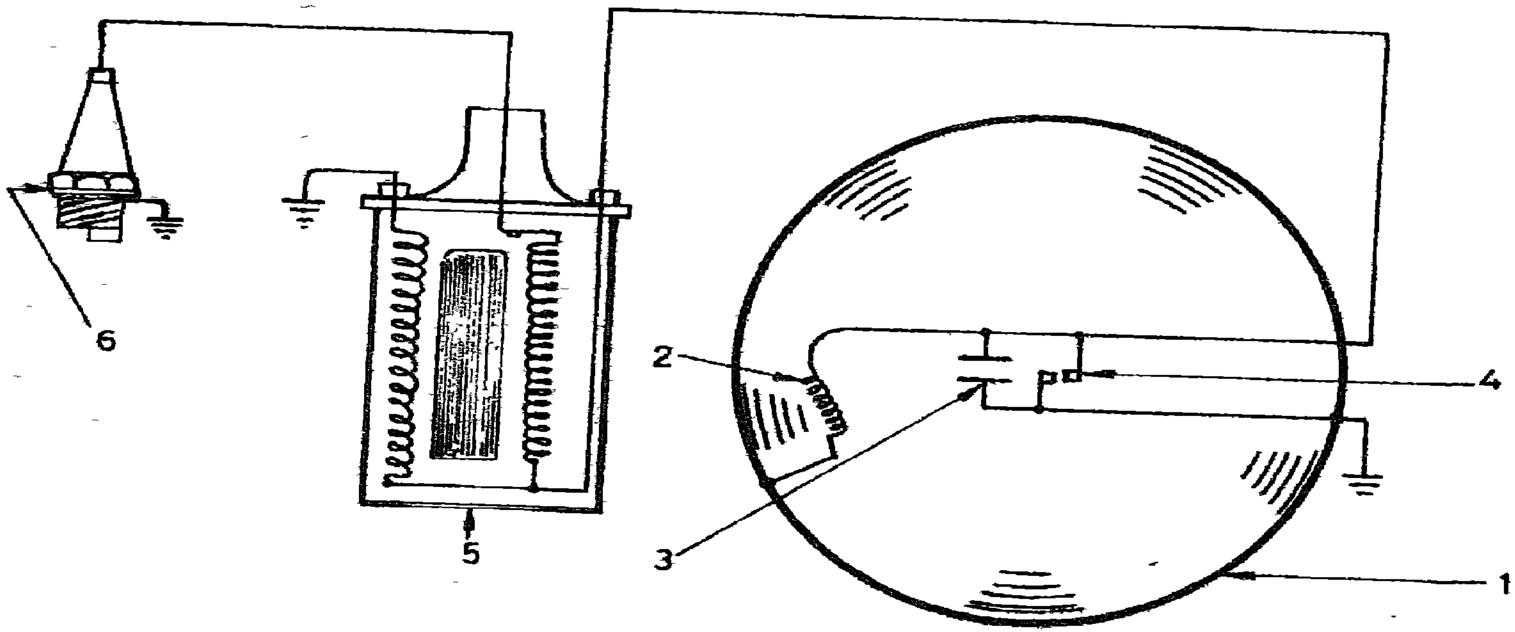


FIG.- 2·1·3 - MAGNETO IGNITION CIRCUIT



1 - ROTATING MAGNET
2 - ARMATURE COIL
3 - CONDENSER
4 - C. B. POINTS
5 - IGNITION COIL
6 - SPARK PLUG

The most common battery is of the Lead-acid type.

1. (a) Equipment

i. Batteries : Sectionalised and Test-Battery
ii. Cell Tester
iii. Hydrometer
iv. Battery charger of the multiple battery type.
v. Electrolyte (Dilute Sulphuric acid of S.G. 1.300)
vi. Distilled water for topping
vii. Petroleum Jelly (Vaseline)
viii. Thick terminal wires.
ix. Terminal Connectors
x. Battery terminals
xi. Loose wires and crocodile clips.

(B) Tools

i. Double ended spanner set
ii. Ring spanner set
iii. Puller
iv. Screw Drivers,
v. Combination Plier with insulated handle

CONSTRUCTIONAL FEATURES OF A 12 VOLT BATTERY (REFER FIG NO: 2.1, 2.2, 2.3.)

No.	Name of the Part	Material/composition if it is an alloy	Purpose	Colour	Remarks
	Nagative Plate	Active Material/Sponge lead (Pb)	To provide negative terminal	grey	It is a good conductor of electricity
	Separator	Cedar wood or fibre glass.	To keep the + Ve and -Ve plates apart to avoid contact.	Defferent colours depends upon the manufacturer	- do -
	Positive plate	Active material-Lead peroxide (PbO2)	To prodive positive terminal	Brown	Integral with container provi at Moulding st
	Segmental space Element Rest	Integral with container Hard Rubber	To support the Group of -Ve and +Ve plate elements and to permit collection of sulphates.	Brown	
	Container	Hard Rubber	To serve as an enclosure for battery and elements	Invariably Black	
	Terminals (a) Negative (b) Positive	Lead	Built up to contact the + Ve and -Ve group of plates	Grey	

1.	2.	3.	4.	5.
8.	Filler cap	Any plastic material	To cover the hole through which the electrolyte/ distilled water is to be poured	
9.	Cover	Hard Rubber	To seal the cell with the container	Black
10.	Cell connector	Lead	To connect two cells in series	Grey
11.	Electrolyte	$H_2 So_4$ 40% + distilled water 60%	Activator of chemical reaction	-

Charging and Testing Procedure.

1. Check the specific gravity of the electrolyte with hydrometer. If less than 1.250, then the battery requires charging. (See Fig 2.1 and 2.5)

2. Also check the voltage across terminals of each cell with cell tester. If the voltage for each cell is less than 1.5 volts; this also indicates that battery requires chasging. (Refer figure 2.6)

3. Top up the electrolyte in each cell by adding distilled water. The level should be 1 cm above the plates.

4. Clean the top surface of the battery.

5. Connect the battery across the battery charger using crocodile clips.

6. Switch on the battery charger. Make sure that the battery is connected with correct polarity. In case, the battery is connected wrongly, the indicator will light up. Make the required correction.

7. If the battery charger is automatic, then it will adjust the level of current automatically otherwise adjust the supply, such that the intensity of the current is not more than 3 amps. For charging new batteries, the current intensity should be kept as low as 1.5 amps.

8. Depending upon the capacity of the battery the hours of charging can be determined. For example, if the battery is of capacity 120 amps. hours, then if the c-harging current intensity is set at 12 amps then to charge the battery fully 10 hours will be needed. Similarly if this battery were a new one, it will require at least 80 hrs when the current is set at 1.5 amps.

9. Check the specific Gravity of the battery after charging. The value should lie between 1.28 to 1.300. Also check the voltage across each cell with cell tester. The reading with fully charged battery should be more than 1.75 volts. The reading should be steady.

10. Switch off the charger. Remove the crocodile clips from the battery terminals. Clean the top surface and place the plugs in position.

Guide to the condition of battery.

Specific Gracity of Electrolyte		Condition of battery
1.265 - 1.290	....	Fully charged
1.235 - 1.260	....	Three fourths charged
1.205 - 1.235	....	Half charged
1.170 - 1.205	....	One fourth charged

1.140 - 1.170	Barely operative
1.110 - 1.140	Completely discharged.

Precautions.

1. Connect battery to the battery charger with correct polarity.

2. Keep the top surface of the battery clean and dry to avoid local discharge. If required use Ammonia or baking soda solution for cleaning purpose which should be thoroughly flushed with water.

3. Do not charge the battery with amperage higher than the recommended value.

4. Do not fill the electrolyte too high. Otherwise, it may bubble over during charging.

5. While making connections of the battery to the charger ensure that the charger is switched off.

6. Never bring a flame or permit sparks to develop-near the battery when it is being charged.

7. Do not hammer the terminals for connecting the clamps.

8. Use proper size clamps.

9. Apply vaseline on the terminals to avoid any deposites.

10. Check the specific gravity of the battery once a fortnight.

Evaluation

1. The proportion of H_2SO_4 and water in the electrolyte in the battery is

   (a) 1:2 (b) 1:3 (c) 2:3 (d) 3:2

   A fully charged battery has a specific gravity of

   (a) 1.25 (b) 1.24 (c) 1.[illegible] (d) 1.[illegible]

2. To avoid the sulphation on the battery terminals use

   (a) Grease (b) Oil (c) S.A.E-20 (d) Petroleum jelly

3. For checking the condition of the battery the following one of the instrument is necessary

   (a) Hydrometer (b) Ammeter (c) Voltmeter (d) Generator

4. Why are the battery terminals tapered?
5. Why should the battery top be kept dry and clean ?
6. W-hy should one avoid bringing a flame near the battery while it is being charged ?
7. Why should the recommended charging rate be observed ?
8. What happends to the battery if it is not in service for a long period of time ?
9. How would you store a charged battery ?
10. What is the effect of temperature on specific gravity of the electrolyte ?

Identification of Various Components.

OBSERVATION SHEET

Name of Student.

Date of Expt.

Sl.No.	Name of the part	Material/ Composition if it is alloy	Purpose/ Function in brief.	Remarks

Signature of Incharge

OBSERVATION OF SPECIFIC GRAVITY OF EACH CELL

Sl.No.	Cell No.	Sp Gravity	Defective/Effecient
1	1		
2	2		
3	3		
4	4		
5	5		
6	6		

RESULT / SUGGESTION

OBSERVATIONS OF EMF BETWEEN EACH CELL

Sl.No.	Cell No.	Voltage/EMF	Defective/Effective
1	1		
2	2		
3	3		
4	4		
5	5		
6	6		

RESULT

SUGGESTION

/TARA/

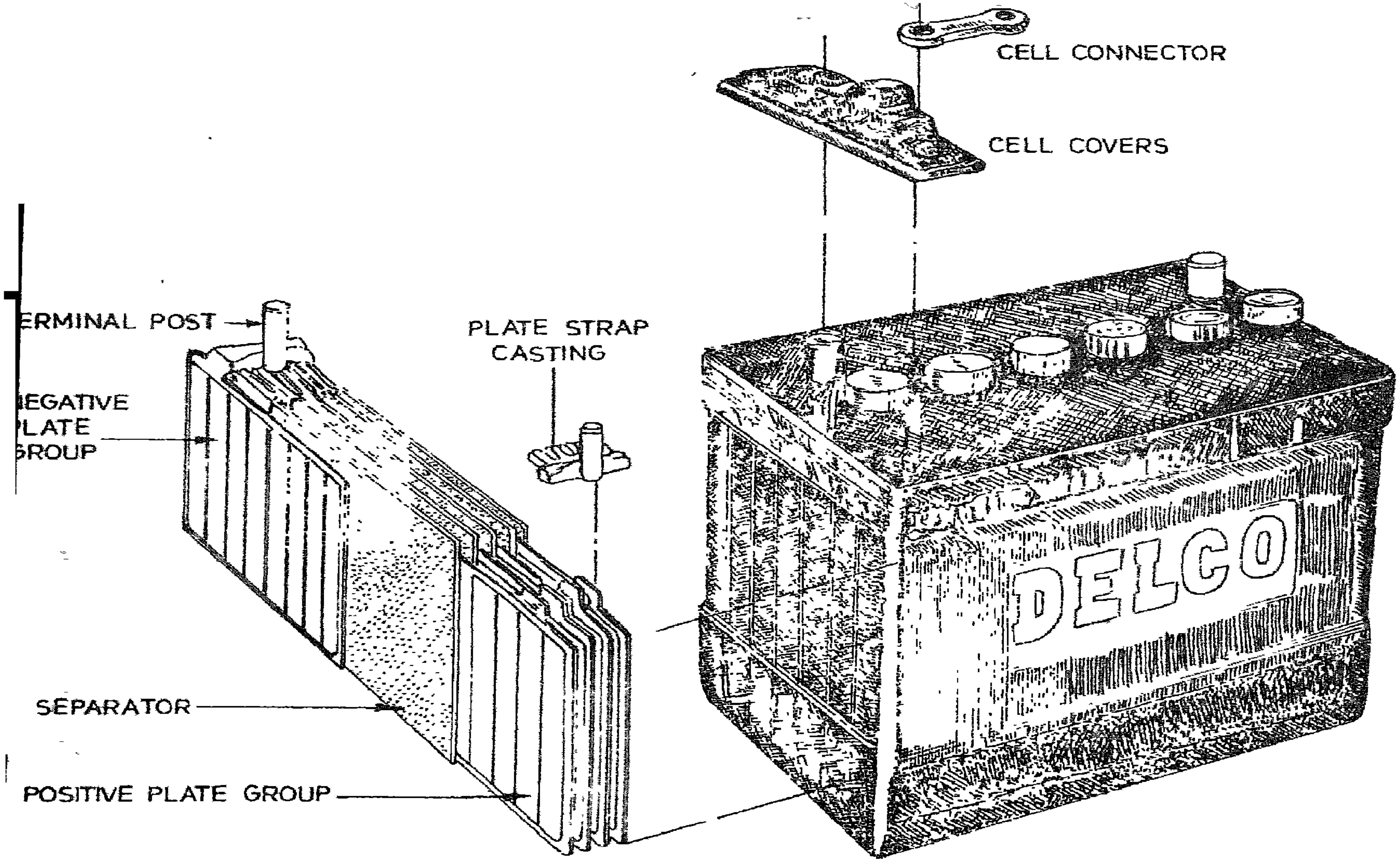
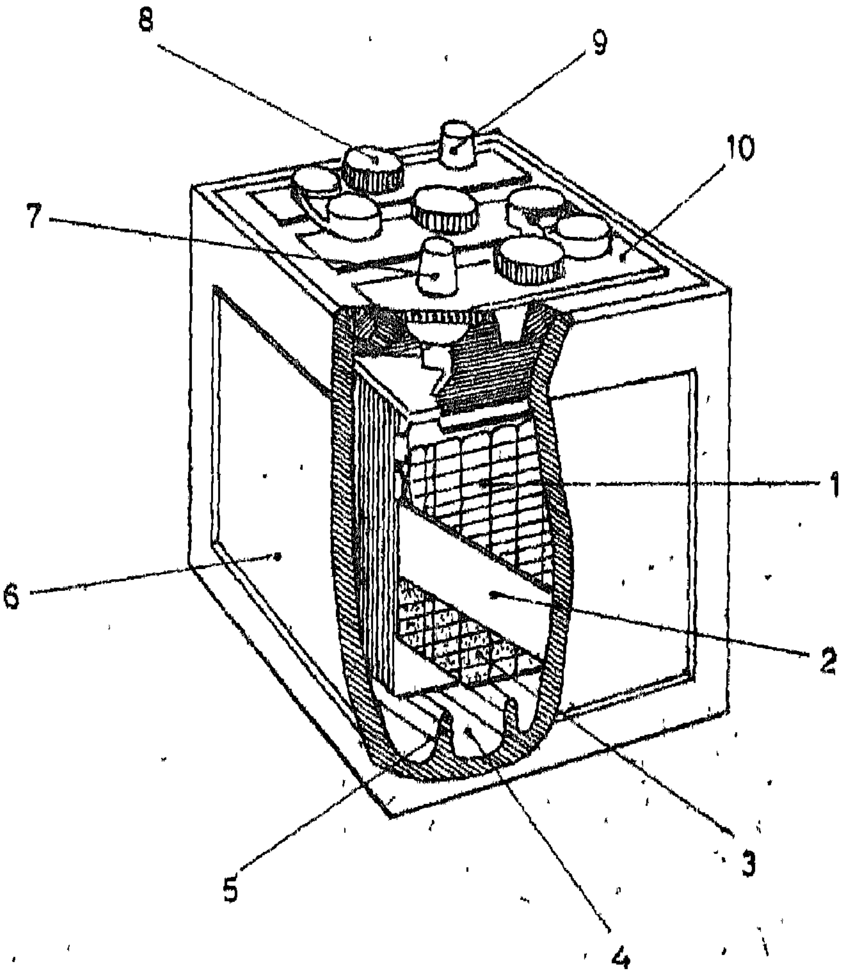


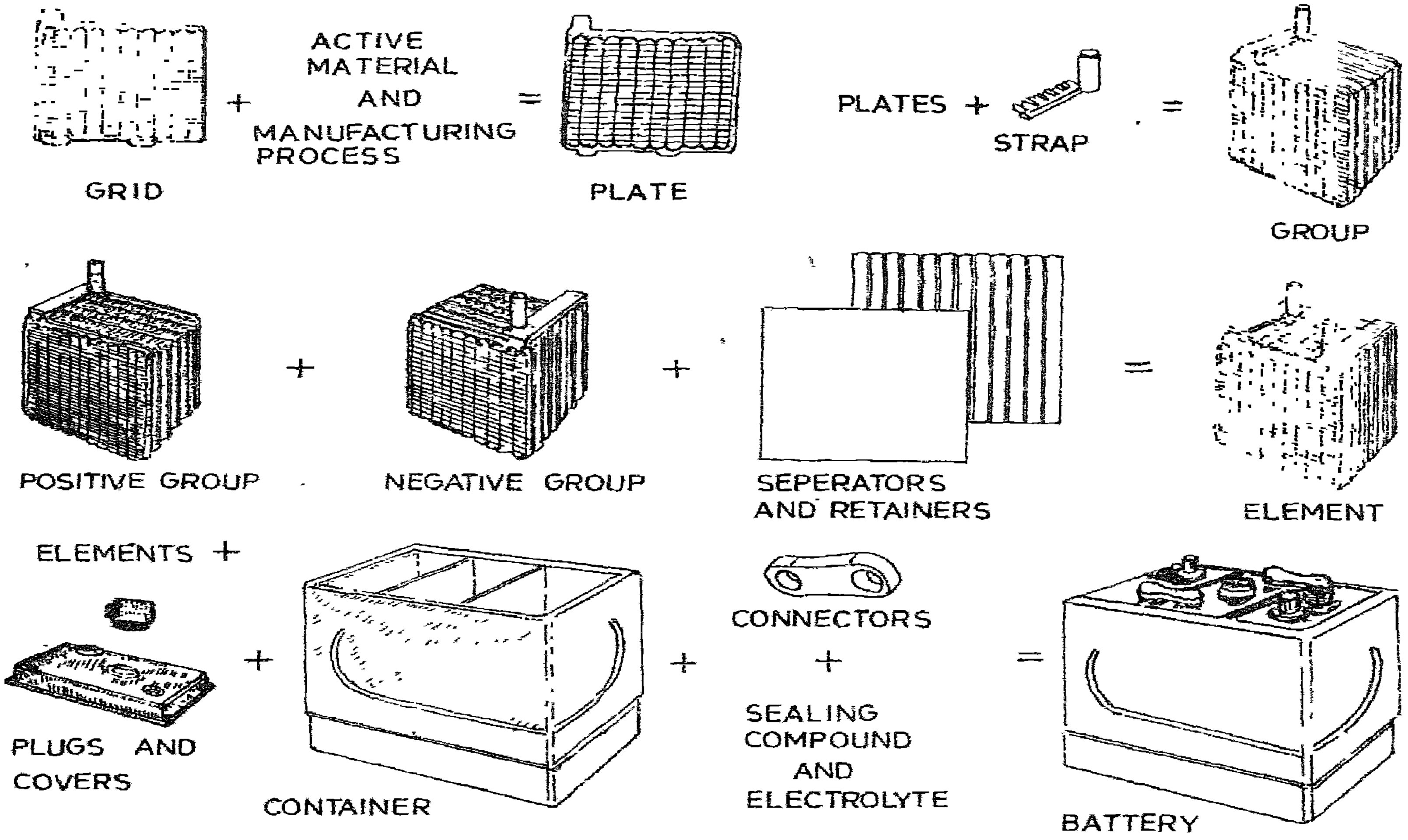
FIG.- 2-2-1 - SECTION VIEW OF A 12 VOLT BATTERY

FIG.-2.2.2 - PARTS OF LEAD ACID BATTERY



1 NEGATIVE PLATE
2 SEPARATOR
3 POSITIVE PLATE
4 SEDIMENT SPACE
5 ELEMENT REST
6 CONTAINER
7 NEGATIVE TERMINAL
8 FILLER CAP
9. POSITIVE TERMINAL
10 COVER

FIG.-2-2-3 - PARTS AND ASSEMBLY OF A LEAD TYPE STORAGE BATTERY



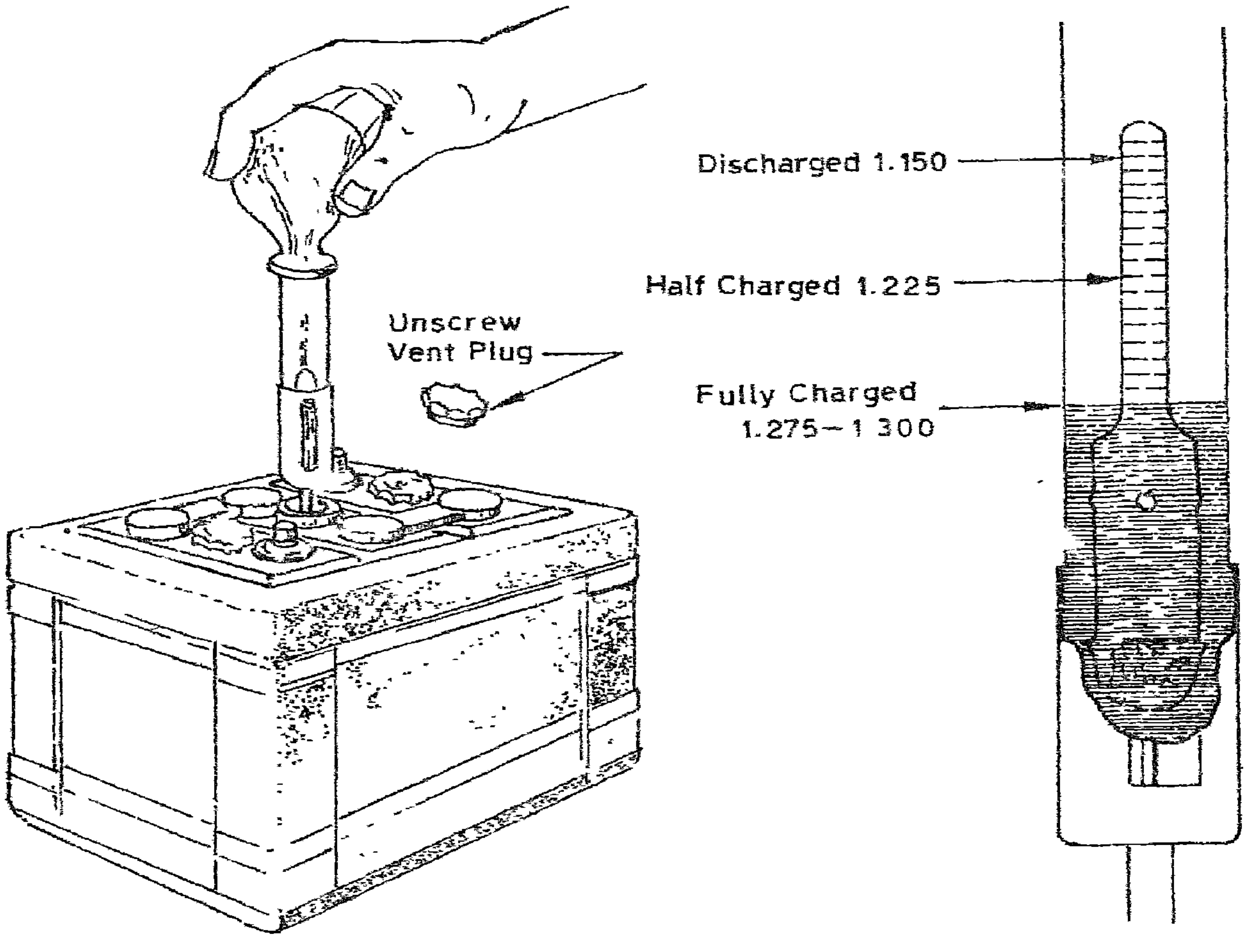


FIG.- 2-2-4 - TESTING SPECIFIC GRAVITY WITH A HYDROMETER

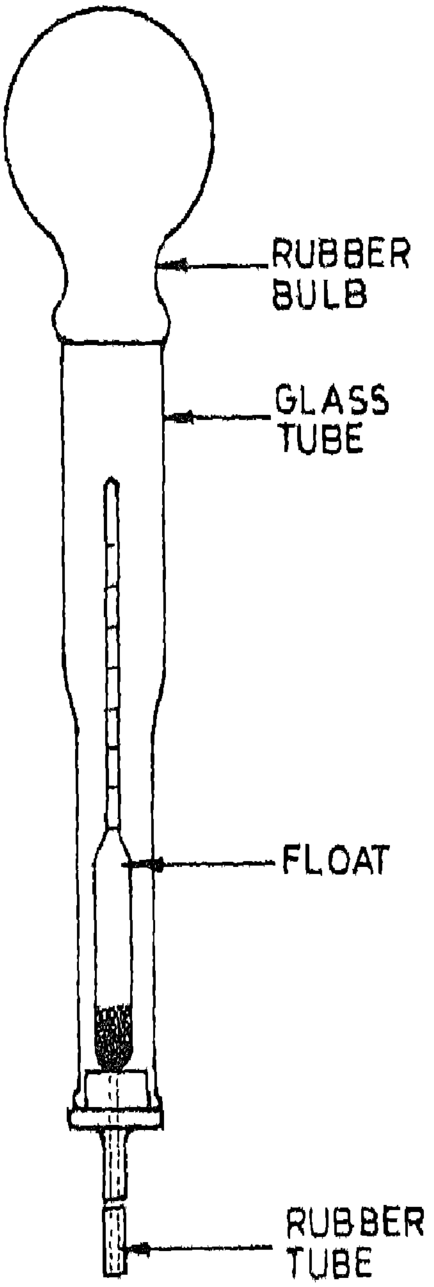


FIG NO - 2.2.5 BATTERY HYDROMETER FOR MEASURING SPECIFIC GRAVITY OF BATTERY ELECTROLYTE

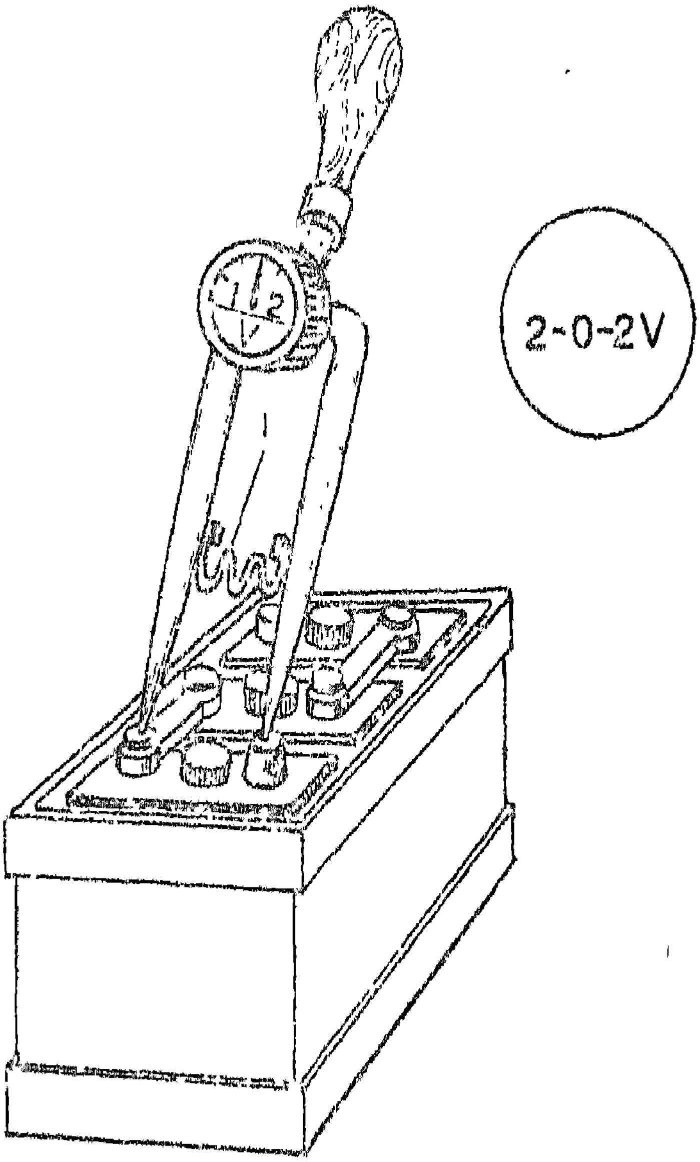


FIG NO-2.2.6 CELL TESTER
1. RESISTOR

Expt. No. 2.3

General Objective

To understand construction and working of ignition coil.

Specific Objectives

1. To identify the components of ignition coil.
2. To know testing of ignition coil.

Introduction

The ignition coil transforms or steps up the low voltage of battery or magneto to a voltage high enough to produce a spark across the spark plug electrodes. The coil consists of primary winding of approximately 100 to 200 turns of gauge 20, enamelled copper wire, and secondary winding of gauge 40, enamelled copper wire of 16,000 to 23,000 turns. The windings are wound around a soft iron core in order to concentrate and produce a strong magnetic field. The primary winding of the ignition coil usually has a resistance in the range of 2.50 to 3.0 ohms and the maximum current that will flow through the primary circuit with ignition switch on is between 4 to 5 amperes.

In general, there are two types of ignition coils one type is metal clad or can type used in cars and the other core type which is also called dry type and is used on scooters and mopeds.

Equipment

1. 6 Volt Ignition coil
2. 12 volt Ignition coil
3. High tension wires
4. Low tension wires
5. Ignition coil Tester
6. 6-V and 12-V Battery

Tools

1. Combination Pliers (Insulated Handles)
2. Screw Driver (Insulated Handle)
3. Double Ended spanner set.

To Understant construction of the ignition coil refer fig. 3.1

The various components of the coil are

1. Primary winding
2. Secondary winding
3. Soft Iron core
4. Low voltage terminal
5. High voltage terminal
6. Paper insulation
7. Porcelain insulator
8. Metallic case

Working of Ignition coil

The working principle of the Ignition coil is mutual induation. As and when there is collapse of magnetic field it causes flow of current in Primary and secondary. The common factor being the association of voltage which remains same for Primary as well as secondary turns. The voltage which is developed in Primary is (120 Volts) called back emf. which almost rises to ten times the charging value (12 volt). If there are 100 turns then the voltage associated with each turn will be 1.2 volt. If there are 16,000 turns of secondary then the total voltage developed in the secondary will be 16000X1.2 = 19200 volts. This voltage is sufficient to develop a spark in the spark plug. The magnetic field developed depends upon the current in the Primary and the concentration of it will depend on the core we provide. A soft Iron core has proven the best to concentrate the magnetic field A condenser of 0.25 MFD capacity in parallel to the Primary circuit is sufficent to assist the Ignition coil to do its duty.

Testing of Ignition coil

To test the ignition coil on the engine.

(A)

1. Remove a spark plug wire and hold it 1.5 cm from the base of the plug.
2. Start the engine

3. If the spark jumps this gap with the [illegible] idling, the coil is good

NOTE: This is a check on the entire ignition system, a weak spark here means ignition trouble, not necessarily coil trouble.

(B)

1. Remove the center wire from the distributor cap.
2. Turn on the ignition switch.
3. Remove the cap and rotor.
4. Place a piece of insulation between the points.
5. Hold the center coil wire 1.4 cm from any ground.
6. Slide a screw driver up and down while making contact with the insulated point.
7. A long high tension spark means a good coil.
8. A poor spark indicates a faulty ignition coil.

To test the Ignition coil on Test Bench

1. Remove the coil from the car.
2. Attach the test lead clips to both primary terminals.
3. Adjust the meter needle to Zero with the set control to the off position

4. Turn the selector switch to the coil set position and adjust the set control so that the meter needle rests on the set mark

5. To make an efficiency test, adjust the control knob to the specifications given in the chart for the coil

6. Note the meter reading. A reading in the good Zone indicates that the coil is up to specifications.

7. To test the coil secondary, turn the selector switch to the secondary position and connect the test lead clips - one to the primary and the other to the secondary. Coil that does not register in the good Zone should be replaced.

8. To test a coil for ground, connect one test lead to one primary terminal and the other to the case, the meter should read Zero with the selector switch on the res. ohms position.

PRECAUTIONS:

1. Keep the Ignition Switch in OFF Position whenever the engine is not working.

2. Replace the condensor immediatity as soon as it becomes faulty. Faulty condensor will damage the ignition coil.

3. Do not allow wetting of the H.T Connection to the Ignition coil.

4. Maintain the re-commended gaps at the C.B. Point and spark plug.

5. Make the L.T. connections to the primary terminals as per Service Manual.

6. Do not keep the connections both at primary and Secondary loose.

7. NEVER repair but REPLACE the weak Ignition coil.

OBSERVATION SHEET

S.No.	Name of the part	Material	Purpose	Remarks

EVALUATION

1. The ratio of Secondary and Primary winding in Igntion Coil is____________________________

   a. 1 : 180 b. 180 : 1

   c. 1 : 1800 d. None of the above.

2. H.T. wire is Connected to primary winding. (True/False)

3. The primary winding of 6 Volts battery has a Resistance range of

   a, 1 to 1.5 ohms b. 1.25 to 1.5 ohms

   c. 1.5 to 1.55 ohms d. 1.6 to 1.7 ohms

4. The no of turns of the Secondary winding is greater than primary winding

   True/False

5. The Secondary winding coil wire is weaker than primary winding coil wire (True/False)

ANSWER

1. b
2. False
3. b
4. True
5. False

/This

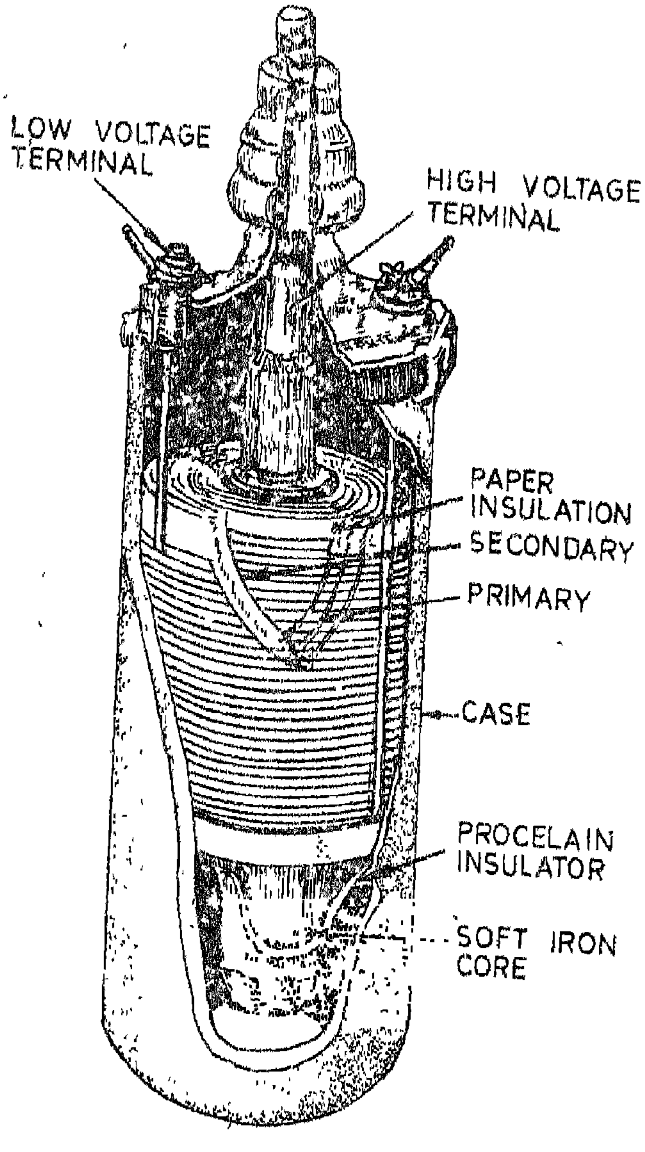


FIG NO-23.1 CUT SECTION OF IGNITION COIL

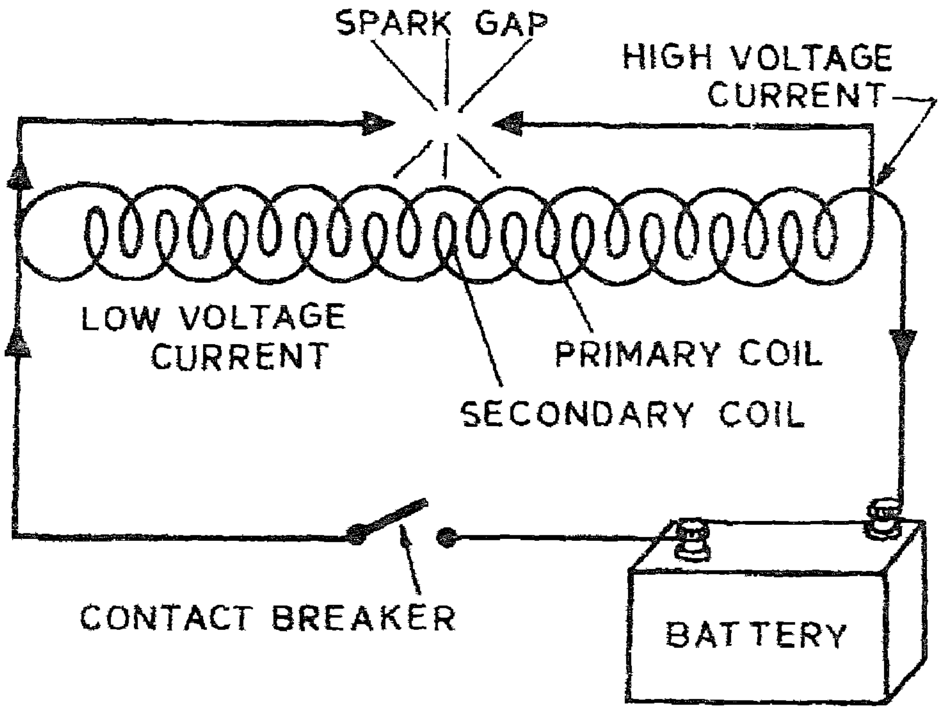


FIG NO - 2.3.2 CIRCUIT DIAGRAM OF THE IGNITION COIL BOTH THE PRIMARY COIL AND THE SECONDARY COIL ARE WOUND ON THE SAME IRON CORE.

Experiment No. 2.4

1. General Objective :- Study of Condenser

2. Specific Objective:

   a) - To understand the construction and working of the Condenser used in Automobile Ignition System.

   b) - To test the given Automobile Ignition Condenser.

3. INTRODUCTION:

The Condenser is a device which will store an electric charge when an electromotive force (emf) is applied at its terminals. The condenser serves two purposes in the functioning of the ignition system.

1. It controls the rate of collapse of magnetic field in the ignition coil thereby increasing the induced emf.
2. It controls the arc current between the contact breaker points, thereby reducing the arcing and prolonging the contact breaker point life.

4. Equipments & Tools

1. Given condensers
2. Condenser tester
3. Screw Driver and
4. Running engine.

CONSTRUCTION

(Refer Fig. No. 2.4.1.)

A Condenser consists of two metallic plates (Lead/Tin/Aluminium Foil) placed in close proximity to each other but separated by a thin layer of insulating paper (Tissue paper). Both the plates are connected to electric leads. One plate is connected to the consenser case or can and the other plate is connected to the condenser lead. The plates and papers are rolled tightly on an arbor to form a winding and placed in the condenser case or can. The winding is impregnated in oily or waxy substance to improve the insulating properties of condenser paper and the condensers are hermetically sealed against moisture.

WORKING

The Condenser is connected across the contact breaker points. When the points begin to open, the condenser momentarily provides a place for the electrons to flow. The condenser stores these electrons until it becomes fully charged, but by this time, the contacts have opened wide enough to prevent the current from continuing to flow. If the condenser were not in the circuit, the current would continue to flow across the contact points after they begin to open and producing an arc. This arc would not only burn the contacts and make them inoperative, but it would allow the current to reduce in value gradually (resistance). Thus the condenser acts both as a reservoir for current and as a check on the current which quickly stops the flow of current in the primary. The sudden interruption in the flow of primary current causes a quick collapse of the magnatic field in Ingition coil. This, in turn, causes a back emf in the primary and induces a very high voltage in secondary winding.

The ability of a condenser to accommodate excess electrons is known as its capacity. The capacity of a condenser is proportional to the surface area of the sheet of conducting material, inversely proportional to the distance between the sheets of conducting material, and proportional to a property of the Insulating material know as its specific inductive capacity. The capacity of Automobile condensers are measured in Microfarads and its value range from 2.2 to 0.35 Microfarads.

Testing the condenser for defects:

A Condenser is always tested on a higher voltage then under which it operates. The condenser must be able to take a charge and hold it.

The Condenser should be tested for

1. Insulation break down
2. Low Insulation resistance or leakage
3. High series resistance and
4. Capacity.

1. Breakdown is a failure of Insulating material, a direct short between the plates of the condenser.

2. Low Insulation resistance of leakage prevents the condenser from holding a charge. A condenser with low insulation resistance is said to be 'weak'.

3. High series resistance is excessive resistance in the condenser circuit due to broken strands in the condenser lead or defective connection.

4. The Capacity of a condenser is determined by the quantity of electrical charge it can hold for a given electrical pressure. The capacity is measured in microfarads.

Generally the condensers are tested with out equipments. Since the cost of condenser is comparatively low it is rather replaced and is not subjected to rigorous checks, A condenser can be tested for being short circuited (excessive leakage) by charging it from a spark plug on an engine that is running, keeping the spark plug gap less than 0.030 in (0.75 mm). Ref, Fig. 2 Ground the condenser case to cylinder head then connect the condenser insulated terminal to spark plug terminal. Remove the condenser and wait for one minute. Then short the condenser insulated terminal to the outer case with a screw driver. One 'Fat' spark should result. It the condenser can not hold the charge for one minute, it is short circuited or has excessive leakage.

Precautions

When the condenser is charged is this manner, the condenser can give you a shock if it can discharge through your body.

The spark plug gap should be less then 0.030" (0.75 mm) and the engine operating in low compression range (idling speed), at this the voltage will not be great to cause condenser insulation to be punctured.

The condenser is always tested with the Ignition coil and if the spark is good both coil and condenser will be good. Both the Coil and condenser are tested in special equipments which are directly calibrated to tell the quality of these units. In such an Instrument the condenser is tested for capacity, series resistance and leakage.

Evaluation Questions:

1. Current flows through a condenser T/F
2. The capacity of condenser is measured in__________
3. The condenser protects the contact breaker points from arcing T/F
4. Insulation is not necessary in a condenser T/F
5. The capacitor is a device which stores/does not store electrical charge.
6. Leaking Condenser will/will not prevent the condenser from holding the charge.
7. Automobile condensers have a capacity range from __________________to______________________.
8. The condenser helps/does not help the rapid collapse of magnetic field in the ignition coil.

ANSWERS

1. FALSE

2. MICROFARADS

3. TRUE

4. FALSE

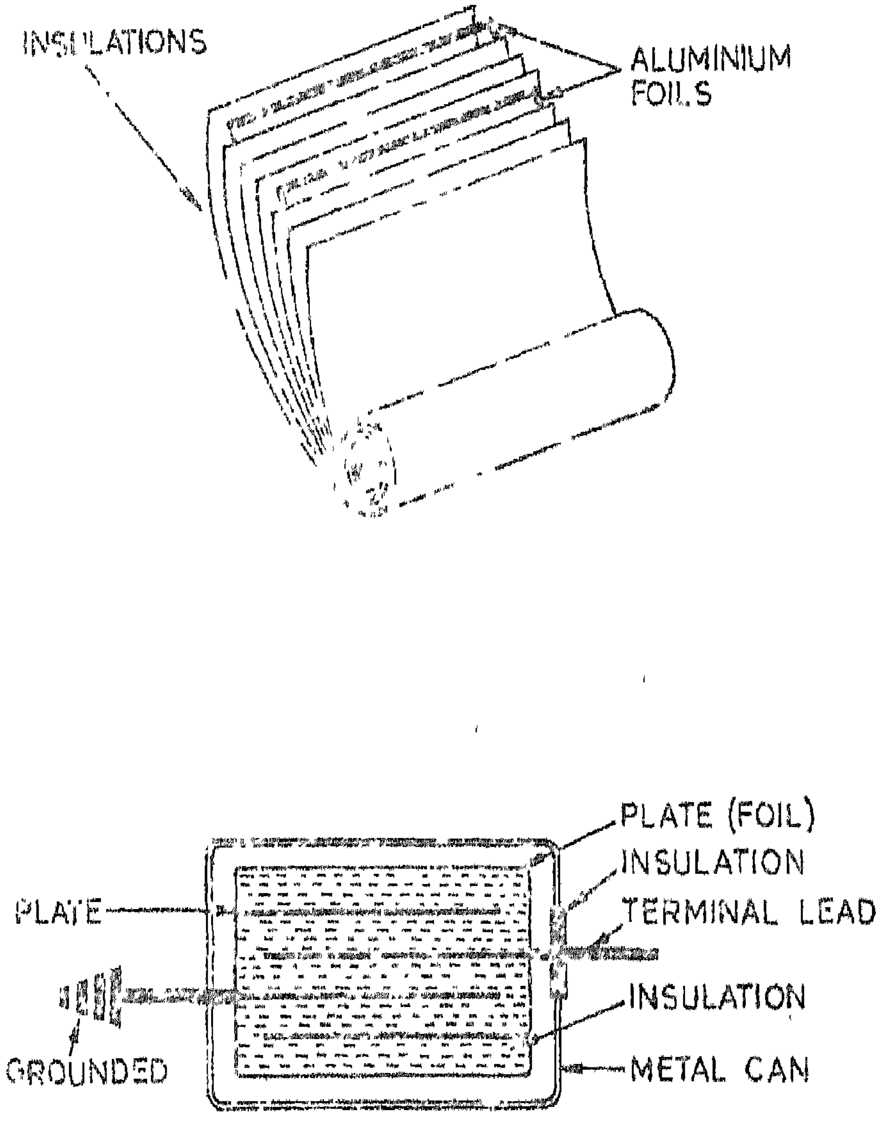
5. STORES

6. WILL

7. 0.2 Microfarads to to 0.35 Microfarads

8. HELPS

/TARA



CONSTRUCTION

FIG.-2.4.1- CONDENSER (CONSTRUCTION DETAIL)

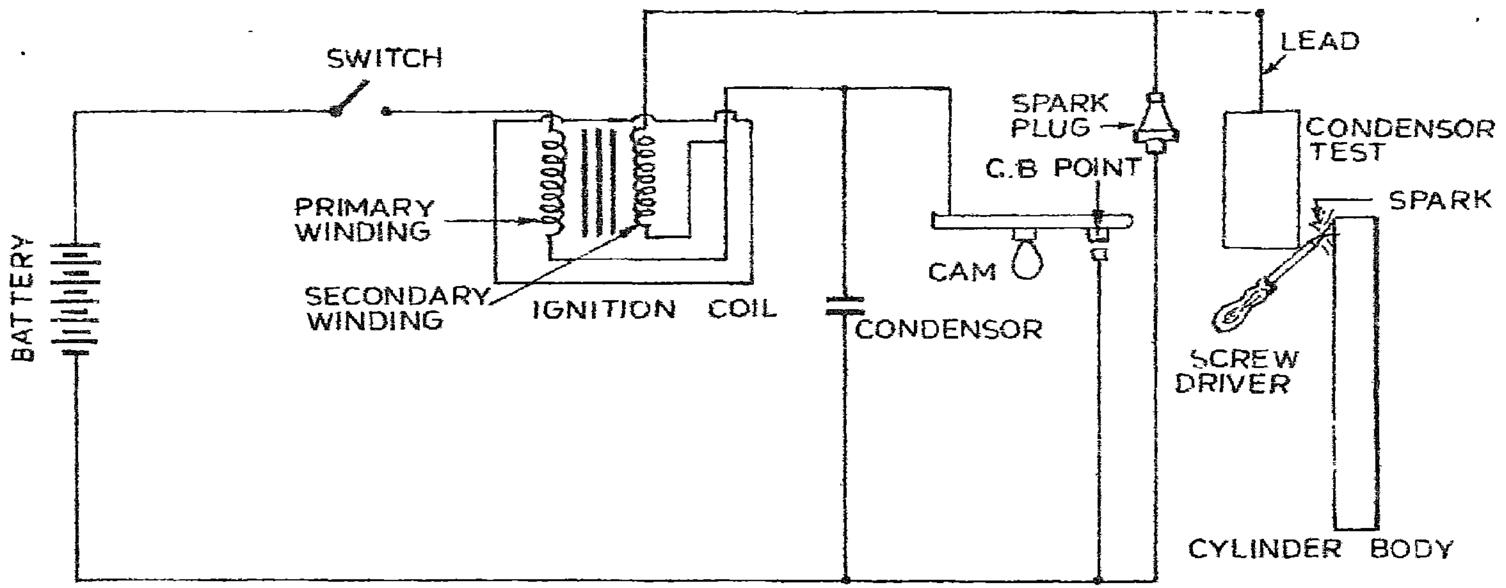


FIG.-2-4-2 - CIRCUIT DIAGRAM FOR CONDENSER TEST WITH A RUNNING ENGINE FOR SHORTED CONDENSER

Experiment No. 2.5

General Objective:- Study of spark Plug.

Specific Objective:-

1. To know constructional details, working and identification of good and bad spark plug
2. To trouble shoot, clean, adjust and test the spark plug.

INTRODUCTION:

The fuel charge in the cylinder of an automobile engine is ignited by a spark created between the electrodes of the Spark plug. Proper Spark plug performance is perhaps the most important factor in maintaining good mileage and engine efficiency.

The Spark plug is threaded into the cylinder head with its lower end protruding into the combustion chamber. It functions in the range of 15,000 to 20,000 Volts between its gaps.

EQUIPMENTS & TOOLS

(a) Equipment

1. Spark plugs
2. Spark plug tester

(b) Tools

1. Plug Spanners for different sizes.
2. Spanner Set-Ring, double ended
3. Feeler Gauge

4. Wire Gauge
5. Knife or Scraper
6. Wire brush and Emery paper

Construction and Working:

The spark plug has 3 principal parts namely the metal shell or body, the central electrode, and the porcelain insulator. The metal shell has a short electrode attached to one side and bent towards the central electrode. There are threads in the metal shell that allow it to be screwed into a tapped hole in the cylinder head. When the spark plug is in position on the engine the metal shell is 'grounded' and acts as one electrode of high tension current. The metal shell is made of steel and above the threaded portion there is a hexagon which takes the wrench/Plug spanner. The porcelain insulator holds the central electrode in position and insulates it from the shell.

The two electrodes are of special heavy wire and there is a gap of 0.02 to 0.03 inches (0.5 to 0.75mm) between them. The electric spark jumps this gap to ignite the air-fuel mixture in the combustion chamber. The construction and materials of the spark plug should be such that the seals between metal base, porcelain and central electrode as well as the porcelain itself must be able to withstand the high pressure and temperature controlled in the Combustion Chamber during power stroke.

The Spark Plugs differ in thread and reach. The reach is the distance between the gasket seat to the end of the threads. The reach determines the position of the spark in Combustion Chamber which is very important for proper flame propagation and efficient combustion of the mixture. Generally engines with Aluminium Cylinder heads use larger reach plugs. It is important to install plugs with correct reach specified by the manufacturer to prevent severe engine damage and to ensure better and stronger fit in the head.

The spark plugs also differ in electrods gap. The electrode gap is the shortest distance between the central electrode and earth/ground electrode. The gap is determined by the manufacturer of the engine and the factors considered are:

-- influence of fuel air mixture on behaviour of engine - under part load - during idling.

-- sudden acceleration.

The gap should be as narrow as possible to minimise the amount of high tension voltage necessary for ignition.

Constructional Features of the Spark Plug

S.No.	Name of the Part	Material	Purpose
1.	Terminal	Alloy of Cobalt & Nickel	To ignite the fuel Mixture
2.	Insulator	Porcelain mica, Sintered alumina	To withstand high Voltage
3.	Upper Sealing Gasket	Copper	Prevent the leakage
4.	Lower Sealing Gasket	Copper	- do -
5.	Shell or Body Assembly	Steel, Zine or Nickel plated	Inserted into cylinder
6.	Central Electrode	Alloys of Silicon, manganeese Nickel chromium	Ignition of Spark
7.	Ground Electrode	Alloy of Nickel, & Manganeese	- do -

Spark Plug Trouble Shooting

S.No.	DEFECT	CAUSE	REMEDY
1.	Fouled by Soot: Colour dull black, Velvety carbon deposits	- Rich Mixture	- Correct Mixture
		- Wider electrode gap	- Set gap to specification
		- Clogged air cleaner	- Clean
		- Poor combustion	- Rings may require replacement
		- Insufficient H.T. Voltage	- Inspect ignition system and rectify.
		- Engine being run at low speeds or light loads	- Use hotter plug as Interim mea
2.	Fouled by oil: Colour shining black 'Wet' Carbon deposits	- Too much oil in combustion chamber due to worn out valve guides.	- Decarbonising and overhauling
		- Worn cylinder & Piston rings	- Replace rings - Overhaul engine
3.	Over heated Metal particles on insulator tip, insulator burnt white,	- Engine over heated	- Use correct reach & heat range of plug
		- Too lean mixture	- Correct the mixture
		- Incorrect Valve timing	- Correct the timing

TROUBLE SCOUTING

A visual Inspection of spark plug will reveal the Engine's operating condition. The residue on the tip of the spark plug can give an idea of the type of problem in Engine performance and an idea of rectification.

TESTING OF SPARK PLUGS

To assess the ignition voltage requirement, insulation properties, etc., test the spark plugs on a spark plug tester, after having adjusted the electrode gap to the recommended value.

* Screw tin the spark plug into the pressure chamber of the tester and regulate the air pressure. Under slight test pressure, the ignition spark will select the easy path over the small gap between the spark plug electrodes.

Increasing pressure, however, necessitates a high ignition voltage so that under sufficiently high pressure the ignition spark prefers to flash over the secondary spark gap which is the open air. The ignition voltage does not rise further when the pressure is further increased.

* The maximum test voltage is thus determined by the secondary spark gap, which operates at approximaterly 18,000 volts. It is, therefore, advisable when checking the insulation capacity of spark plugs, to increase the pressure until the secondary spark gap flashes over.

This is an indication that the maximum test voltage has been reached. The plug is satisfactory if the ignition spark flashes over on the spark plug or on the secondary spark gap or on both of them alternately. It is not in order when one or more sparks flash-over to other spots.

To check the ignition voltage requirement, increase the pressure to such an extent that all sparks flash-over the secondary spark gap. Now reduce the pressure with the control valve until the first sparks flash-over the spark plug electrodes. Record the pressure and compare with the following table:

Electrode gap (mm)	Pressure in kgf/cm² at which the first sparks flash-over the plug electrodes		
	Plug to be replaced	Plug still serviceable	Plug good
0.5	6.5 - 8.5	8.5 - 10.0	10.0 - 12.0
0.6	5.5 - 7.5	7.5 - 9.5	9.0 - 11.0
0.7	4.5 - 6.5	6.5 - 8.0	8.0 - 11.0
0.8	4.0 - 6.0	6.0 - 7.5	7.5 - 9.5
0.9	3.5 - 5.5	5.5 - 7.0	7.0 - 9.0
1.0	3.0 - 5.0	5.0 - 6.5	6.5 - 8.5

MAINTENANCE, CLEANING AND RESETTING OF THE ELECTRODE GAP

If an engine works continuously at maximum power, the combustion temperatures are at their peak most of the time causing faster spark plug wear and tear. Similarly when the engine is operating constantly at light load and low speed it leads to fouling of spark plug. Spark plug electrodes being subjected to high temperatures and at the same-time attacked by corrosive combustion by-products like sulphur gradually demand higher sparking voltage.

The above condition causes misfiring, power loss and excessive fuel consumption and these can be rectified by the following operations of cleaning.

1. Remove spark plug with suitable box spanner and clean the plug throughly in petrol with a brush.
2. Glazed surface of the insulator should be free from oil and dirt.
3. Hard deposits at electrodes should be completely cleaned by "Sand Blasting Method and scrap it before, if they are in dirty condition (Sand blast only 10 to 15 seconds. Moving the top of the spark plug in complete circle.)
4. After completion of sand blasting, the air blasting should be done.
5. If the plug is satisfactory, lightly clean the tip of the centre electrode with emory and facing side of the earth electrode to remove oxides and correct surface detoriorations.

RESETTING OF ELECTRODE:

For setting of electrode gap the spark gap gauge is used. The following electorde gaps are generally used in most of the four wheelers and Two wheelers.

1. Battery Ignition System - 0.6 mm
2. Magneto Ignition System - 0.5 mm

Recommended Life of Spark Plug:

Due to the wear in Electrodes and material deterioration the voltage requirement of the spark plug increase causing strain on the ignition system and ultimately resulting in loss of ignition effieiency, missing, excessive fuel consumption etc. In order to have increased power and reduced operation cost, it is advisable to replace spark plugs at the intervals mentioned:

	Vehicles	Stationary Engines
Four - stroke cycle engines	15000 km	300 hrs
Two - stroke cycle engines	7,500 km	150 hrs

OBSERVATION

SHEET

S.No.	Name of the Part	Material	Purpose	Remarks/ Precautions

/TARA

EVALUATION:

1. The Spark plug's electrode is made up of.

   ( )

   a. Alloy of Aluminium b. Alloy of Steel

   c. Alloy of Silicon d. Bronze

2. The Shapes of the shell of the Spark plug is:

   a. Octagonal b. Square

   c. Heptagonal d. Haxagonal

3. The Spark plug is connected to__________________________

   a. Cylinder b. Combustion Chamber

   c. Distributor d. None of the above

4. The Spark plug is inserted in:

   a. Crankshaft b. Combustion Chamber

   c. Piston d. Radiator.

5. The spark plug gap is measured with:

   a. Screw gauge b. Vernier caliper

   c. Feeler gauge d. Plug gauge.

6. In Mopeds______________________

   No./Nos. of Spark Plugs is/are used.

   a. Two b. One c. Four d. Three

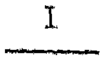
7. Porcelain is used for Insultor part in Spark plug

   (True/False)

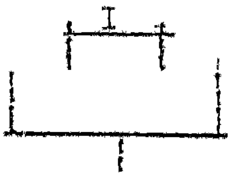
8. The glazed Surface of insultor should be made free from oil and dirt (True/False)

9. Symbol for Spark plug is

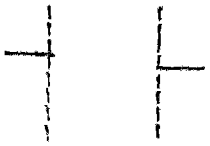
a.



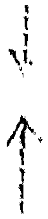
b.



c.



d.



ANSWER

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1. -C	2. -D	3. -C
4. -B	5. -C	6. -B
7. - True	8. True	9. -D

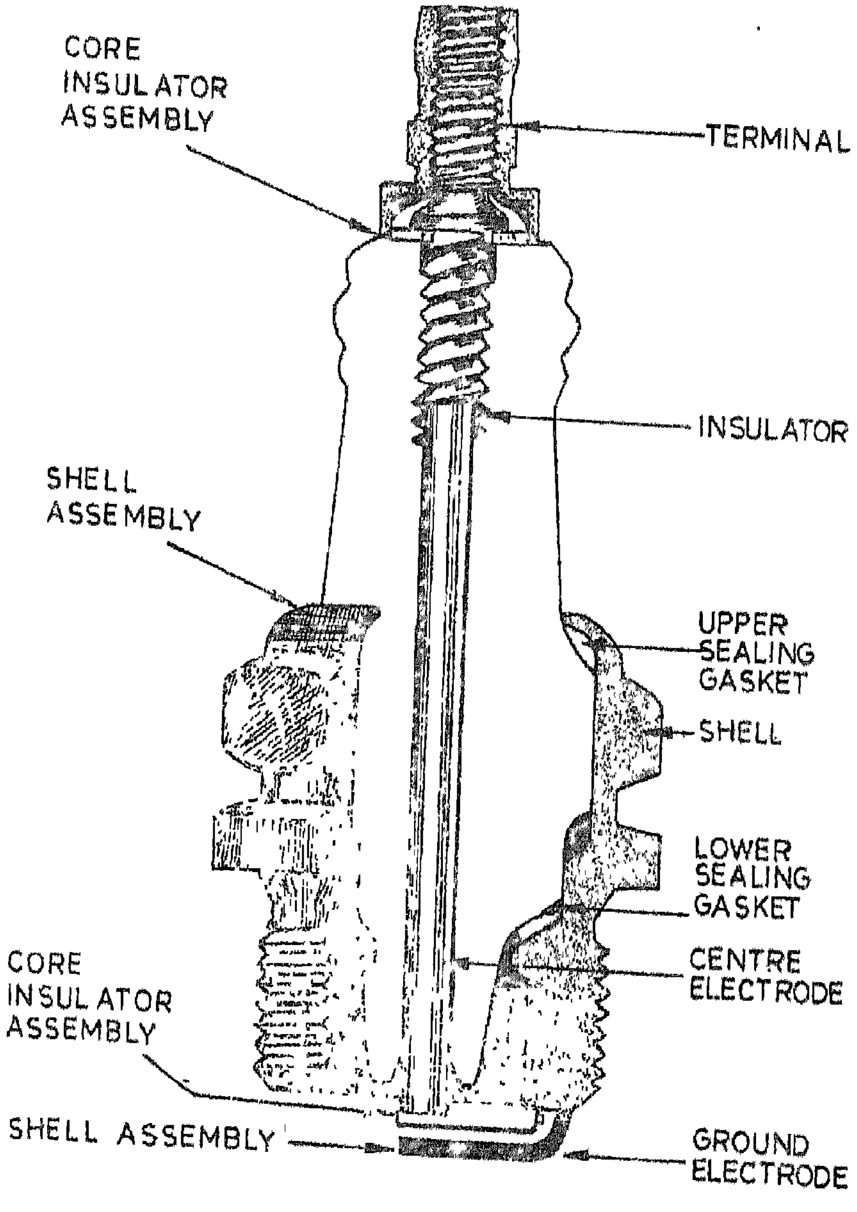


FIG-2.51 SECTIONAL VIEW OF SPARK PLUG.

Experiment No. 2.6

General Objectives: Study of Distributor

Specific Objectives:

1. To know the constructional details and their specific functions.
2. To know the working of centrifugal advance and vacuum advance mechanisms.
3. To dis-assemble, inspect, re-assemble and test the distributor
4. Trauble shooting and rectification.

Equipment:

Distributor

Tools:

1. Spanner set (double ended)
2. Spanner set (Ring)
3. Screw driver
4. Cutting plier
5. Feeler gauge

Introduction

The ignition distributor is the moving mechanical link between the electrical components of the Ignition system and the engine.

The Ignition distributor has two jobs:

1. It closes and opens the circuit between the battery and ignition coil. When the circuit closes, the current flows in the ignition coil and the coil sets up a magnetic field. When the circuit opens, the magnetic field in the ignition coil collapses, and a high voltage surge of current is induced in the coil.
2. It distributes the high voltage current to the correct spark plug at the correct instant by means of the distributor rotor and cap, and the high tension wiring.

The distributor contains a set of contact breaker points (C.B. point) and a cam, having as many lobes as the number of cylinders, ignition advance mechanisms (centrifugal and vacuum), rotor and cap. The distributor shaft is usually driven by the camshaft, at half engine speed, through gears so that the H.T. current is fed to spark plugs at the correct instant. The direction of rotation of the distributor rotor is either clockwise or anticlockwise and this depends upon how the camshaft gets the drive from the crankshaft. The rotor drives clockwise when there is gear drive between crankshaft and camshaft gears, and it drives anticlockwise when there is chain drive between crankshaft and camshaft sprockets.

Ignition Advance (Fig Nos. 2.6.4, 2.6.5 and 2.6.6)

At all engine speeds the combustion of charge takes a similer amount of time. When the engine is idling the spark is timed to occur just before the piston reaches top dead centre on the compression stroke.

As the engine speed increases there is less time between the up and down strokes, so the firing must be advanced to give time for combustion. This is achieved by a centrifugal advance mechanism and supplemented by a vacuum advance unit.

Centrifugal advance:

This consists of two pivoted weights held close to the distributor shaft by springs. The weights throw out against the spring tension as the engine speed increases. This movement is transmitted through a toggle arrangement to the breaker arm causing it to advance or move ahead with respect to the distributor drive shaft. This, in turn, causes the cam to open and close the contact breaker points earlier in the compression stroke at high engine speeds. Since the rotor, too, is advanced, it comes into position earlier in the cycle also. The timing of spark in the cylinder consequently varies from "No advance at Low speed" to "Full advance at High speed"

When the weights have reached the outer limits of their travel (maximum advance may be as much as 45^0. of crank shaft rotation before the piston reaches top dead centre. This value varies with different engines). The toggle arrangement and springs are designed to give the correct advance for maximum engine performance.

Vacuum advance:

Under part throttle, a partial vacuum develops in the inlet manifold. This means that lessor quantity of air and fuel will be admitted to the cylinder (lessor volumetric efficiency).

Thus the mixture will not be compressed to maximum and will burn more slowly when ignited. In order to realise full power from it, the spark should be somewhat advanced. To achieve this spark advance a vacuum advance mechanism is used.

The vacuum advance unit contains a spring loaded and air tight diaphragm connected by linkage or lever to the breaker plate. The breaker plate turns with respect to distributor body as it is supported on a bearing. The spring loaded side of the diaphragm is connected through a vacuum line to an opening in carburettor/ inlet manifold. When the throttle is in idling position there is no vacuum advance.

As the throttle opens the inlet manifold vacuum draws air from the vacuum line and the air tight chamber in the vacuum-advance mechanism. This causes the diaphragm to move against the spring. The linkage to breaker plate then rotates the breaker plate. This movement carries the C.B.Points around, and the cam opens the points earlier in the cycle, spark occuring at the plug gap earlier in the compression stroke. More the opening of the throttle, lesser will be the vacuum in the inlet manifold and hence lesser will be the vacuum advance. At maximum throttle opening, there will be no vacuum advance and at this position the spark advance will be entirely provided by the centrifugal advance mechanism.

Combined Centrifugal and vacuum advances:

At any particulae engine speed, there will be a certain de-finite centrifugal advance due to the engine speed plus a possible additional advance due to the vacuum advance mechanism.

Ref Fig. No. 2.6.7

At 40 miles per hour (64 kph) the centrifugal advance mechanism provides 15° spark advance on this particular application. The vacuum advance mechanism will provide upto 15° additional advance under part throttle conditions. At wide open throttle, this added vacuum advance will be available. The advance is usual operation will vary somewhat between the straight line (centrifugal advance) and curved line (centrifugal advance plus possible vacuum advance) corresponding to different throttle positions.

Cam angle or Dwell angle:

The cam angle or dwell angle (contact angle) is the number of degress of cam rotation from the time, the contact points close until they open again.

The period during which the contact breaker points remain closed is termed as the dwell period or dwell angle or cam angle. Increasing cam angle will decrease the contact point opening and vice versa.

OVERHAULING AND TESTING OF DISTRIBUTOR:-

The Distributor is dismantled and overhauled. After inspection, replacment/adjustments, it is tested for proper functioning in the distributor Test Bench. The overhauling is tested at the stage of tuning the engine. In general, the distributor is attended in a routine manner for lubrication, cleaning and adjustement of contact breaker points. The following will be schedule for routine maintenance.

Duration or Interval	Work	Unit	Method
First 800 Km and every 5000 km. after wards.	Checking & setting	C.B.Points	Set the Gap tp 0.35 to 0.40 mm. in the position of maximum opening corresponding to ignition timing.
Every 5000 km	LUBRICATION	Advancing Mechanism	Smear engine oil at lub. points
		Contact breaker pivot	Pour a drop of engine oil
		Cam	Apply mobil grease
		Spindle	Apply thin M/C oil
		Cam bearing	" " "
			Care must be taken that no oil or grease is getting on or nearer the contact points.
Every 5000 km	CLEANING	DISTRIBUTOR CAP	In side and outside is cleaned with dry cloth.
		C.B.Points	i) Must be free from oil, grease and dirt. ii) Burned and blackened points are cleaned with emery cloth or very fine carborundum stone and wiped with petrol moistened cloth.

Dis-assembly, Inspection and assembly and testing

1. The Distributor can be removed and replaced without interfering with the ignition timing.
2. Remove the Distributor cap by unclamping the spring clips.
3. Disconnect the low tension terminal (Primary connection) on the Distributor.
4. Disconnect the vacuum advance line pipe at the union on Distributor.
5. Extract the bolts that clamp the Distributor clamp plate to the housing and withdraw the Distributor.
6. Lift the rotor off the top of spindle. Care must be taken to take out the rotor if it is tight fit.
7. Remove the movable contact arm after ensuring that the insulations are properly disconnected or removed.
8. Remove the fixed contact plate after removing the fastners holding the plate.
9. Take out securing screws and remove the condenser.
10. Remove the Breaker base plate after removing the spring clip retaining the vacuum advance unit arm or lever, and the screws holding it to the body. Lift out the Breaker base plate.
11. Take out the cam holding screw and remove the cam spindle.

12. Take out the centrifugal weights. These may be lifted out as two assemblies each complete with a spring and toggle.
13. Detach the vacuum advance unit.
14. Release the spindle from body after driving out the driving pin passing through collar of the driving tongue member at the lower end of spindle.

After proper inspection for wear and tear, (repaired if recommended), replacements are made. The Distributor is assembled in the reverse order. The Distributor is then tested on a distributor test bench for different speeds and checked for proper spark advances as specified by the manufacurer for initial, centrifugal and vacuum advances.

The distributor assembly after overhauling and testing is installed back in the engine.

1. Insert the distributor into the housing until the driving dog rests on the distributor drive shaft. The rotor arm should be then rotated slowly until the drive dog lugs engage with the drive shaft slots. There is provision to ensure correct replacement.
2. Turn the Distributor body to align the clamping plate holes with those in the housing.
3. The remainder of assembly is just the reverse as to that of dis-assembly from engine. The ignition timing is again checked before the engine is started, after making necessary Primary and High Tension connections.

TROUBLE SHOOTING

DISTRIBUTOR

Sl.No.	Defect	Cause	Remedy
1.	Engine does not start in wet weather.	a) Moisture inside the Distributor cap.	Dry it with clean cloth.
		b) Distributor Cap cracked.	Replace the Distributor cap.
2.	Engine Mis-fires	Worn-out Breaker plate.	Replace the same.
3.	Rough Engine running.	a) Too advanced ignition timing	a) Retard the engine to the desired limit.
		b) Ignition Advance mechanism not functioning properly.	b) Check and get repaired.
4.	Improper working of contact breaker arm	Due to the less or more tension.	Set tension to 450 gms.

Precentions

1. Keep the ignition switch in OFF position or remove earth connection to battery.
2. Note the sequence of H.T. connection before removing the distributor.
3. Maintain cleanliness.
4. Before installing the cap, ensure that the carbon electrode is in position.

Evaluation:

1. The distributor central terminal is conected to ____________________(a) Primary coil (b) secondary coil (c) Primary secondary coil (d) none of the above.
2. The contact Breaker arm tension is about____________ ANSWER (a) 450 gms (b) 900 gms (c) 100gms
3. Pitted C.B.Points have more resistance

   True/False
4. Carbon brush inside the distributor cap central terminal is hot spring loaded.

   True/False
5. Cracked distributor cap should/should not be replaced.
6. Vacuum advance is maximum/nil at full throttle opening.
7. Distributor shaft gear have________________ Helical/ spur teeth.
8. Distributor shaft speed is________________speed of crank shaft.
9. The material of the Distributor cap is______________ ___________________________________.
10. The dwell angle is defined as_______________________
11. Advancing the spark is/is not necessary as the engine speed increases.

ANSWER

1. -b

2. -a

3. - True

4. False

5. - Should

6. - Nil

7. - Helical

8. - Half

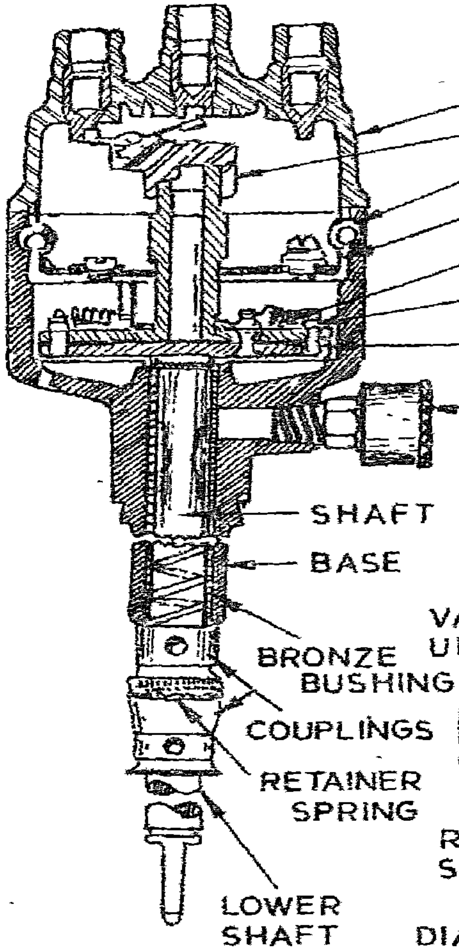
9. -Hard plastic

10. - The period during which the C.B. Points remain closed.

11. - is necessary

/TARA/

FIG NO 2.61 LEFT VERTICAL SECTION THROUGH DELCO-REMY. IGNITION UNIT.



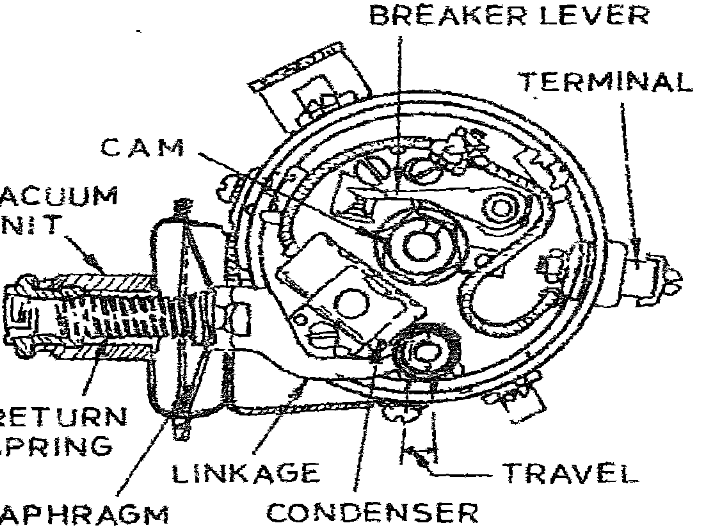
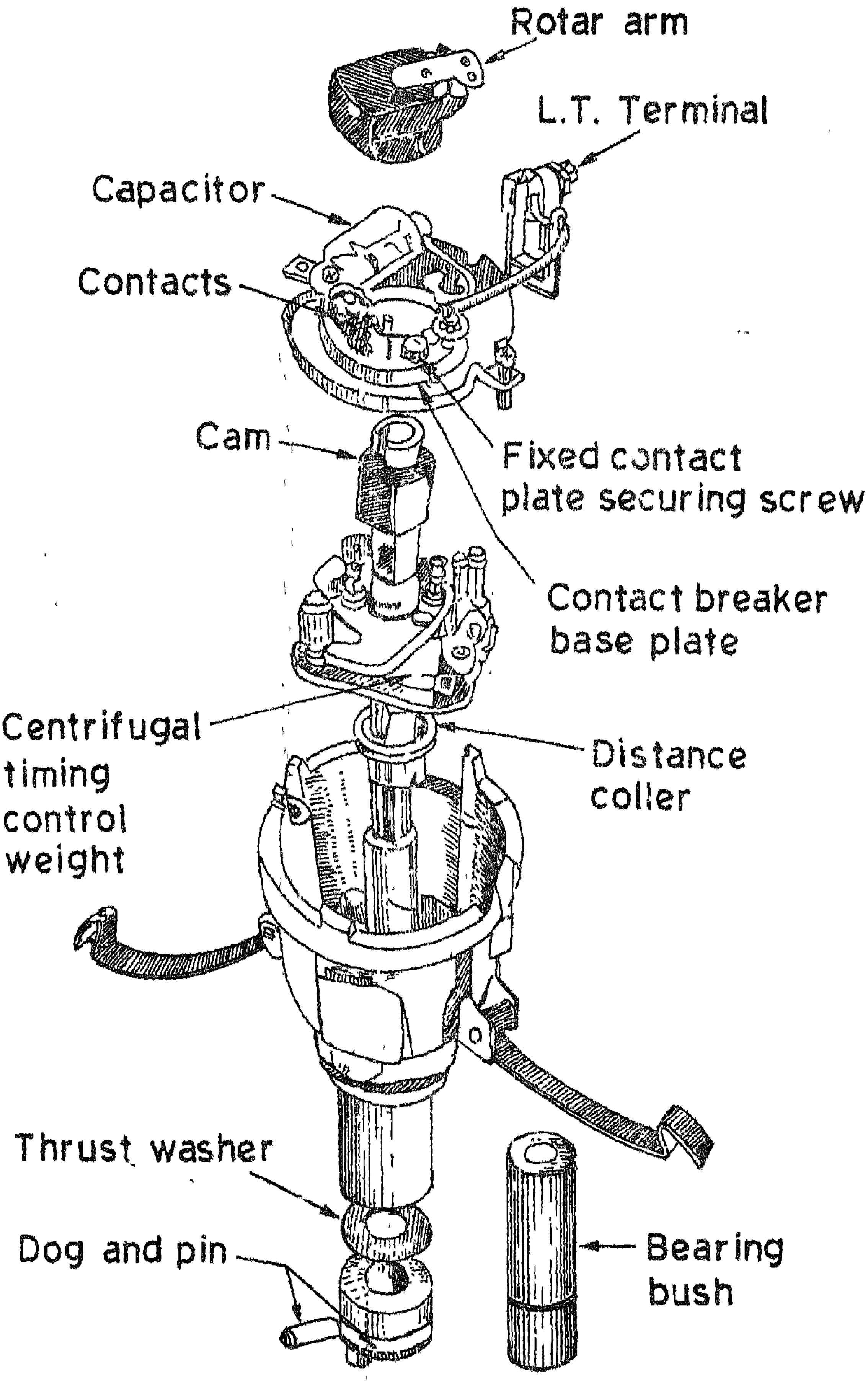


FIG NO- 2 6.2.RIGHT PLAN VIEW OF DELCO-REMY "BREAKER."


Rotar arm
L.T. Terminal
Capacitor
Contacts
Cam
Fixed contact plate securing screw
Contact breaker base plate
Centrifugal timing control weight
Distance coller
Thrust washer
Dog and pin
Bearing bush

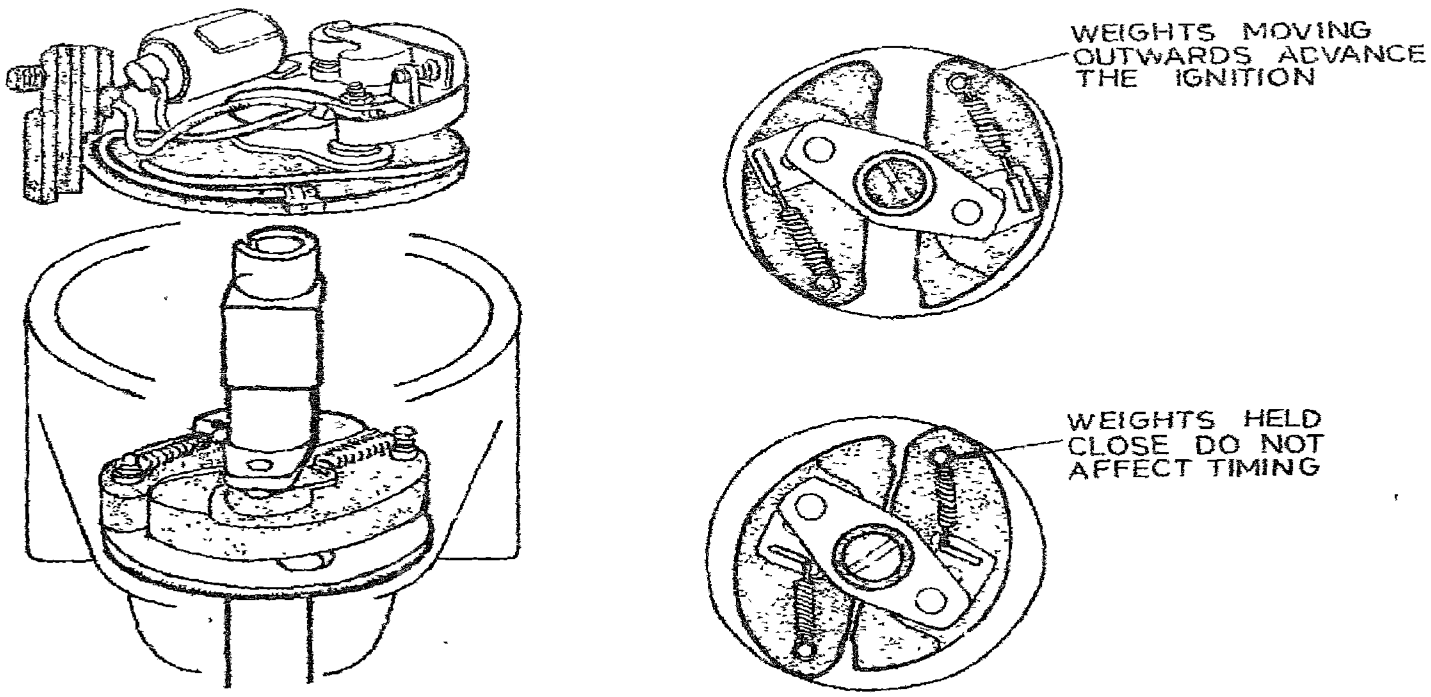

WEIGHTS MOVING OUTWARDS ADVANCE THE IGNITION
WEIGHTS HELD CLOSE DO NOT AFFECT TIMING

FIG.- 2-6-4 - CENTRIFUGAL ADVANCE

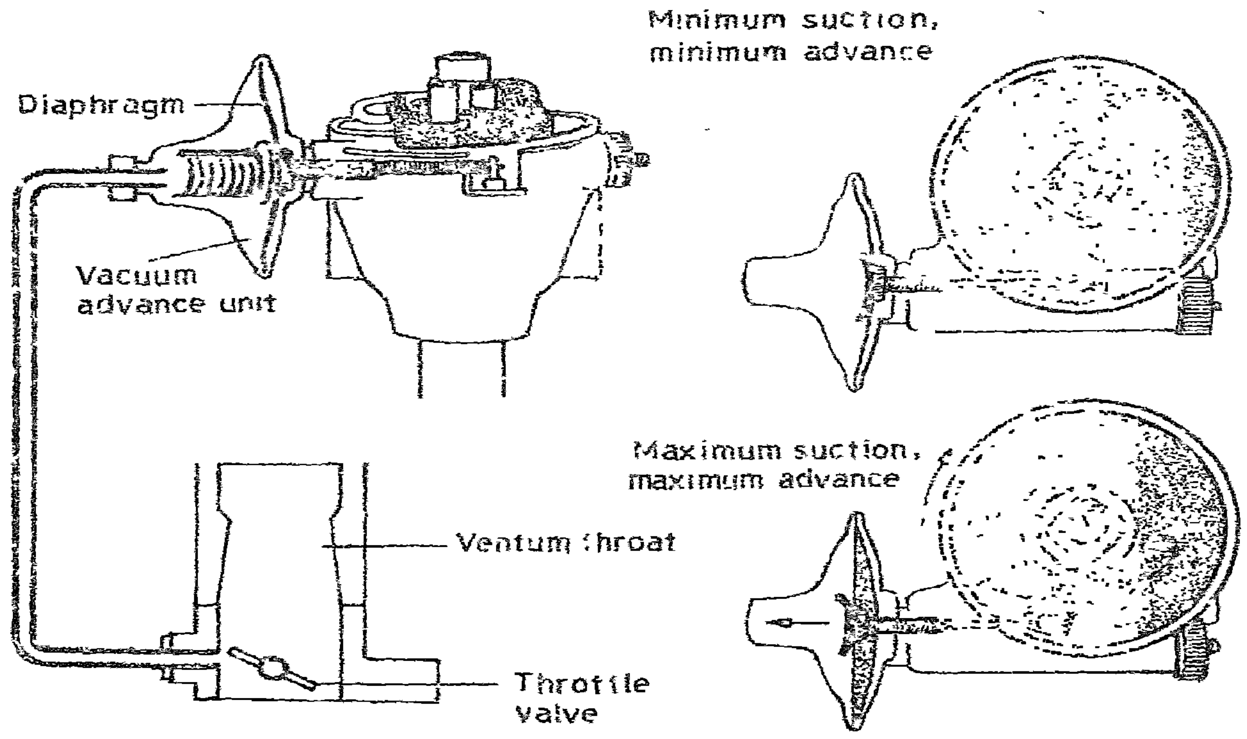


FIG NO -2.6.5 VACUUM ADVANCE

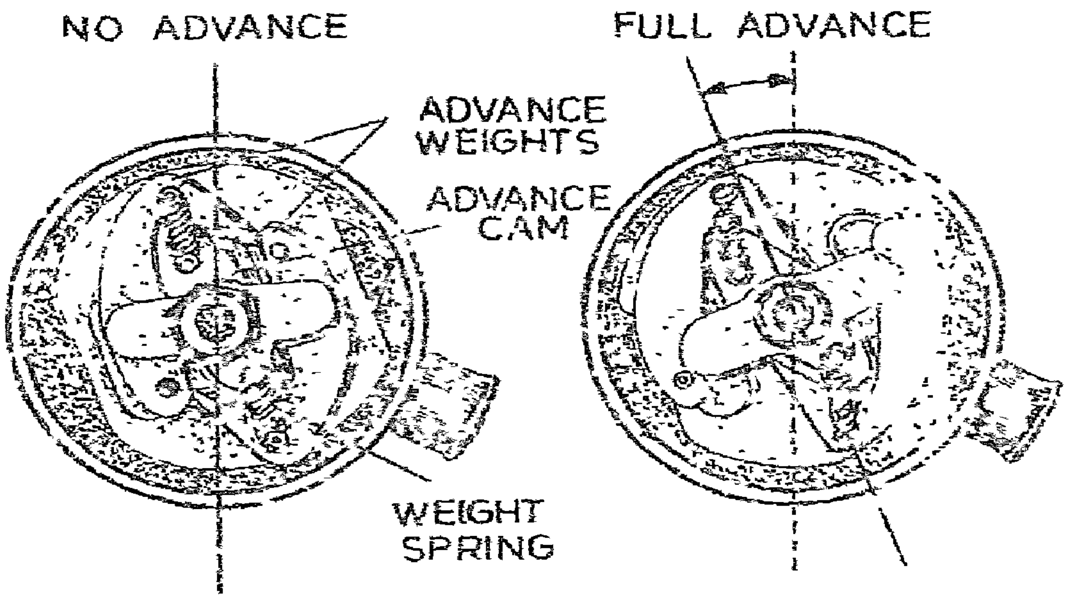


FIG NO - 2.6.6 CENTRIFUGAL ADVANCE MECHANISM SHOWING NO AND FULL ADVANCE POSITIONS.

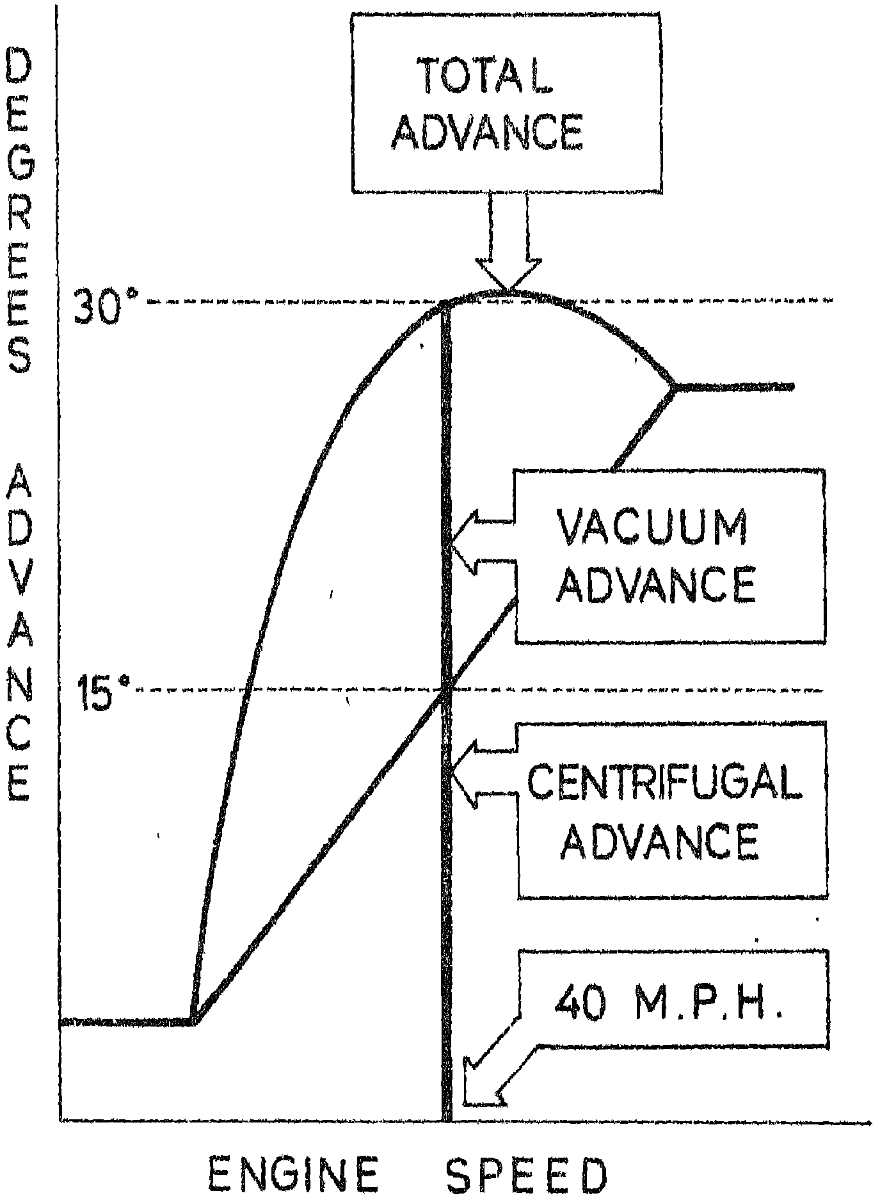


FIG NO-2.6.7 CENTRIFUGAL AND VACUUM ADVANCE CURVES FOR ONE PARTICULAR APPLICATION

Experiment No. 2.7

Specific Objective:

Setting of Ignition timing for an engine.

INTRODUCTION:

As the piston in the cylinder of the engine approaches the T.D.C. in its compression stroke, a spark is applied to ignite the charge. The relationship of the time the contact breaker points separate (open) with respect to the position of the piston in the cylinder during its compression stroke is known as the Ignition Timing. Every engine is provided with the specification for setting the Ignition timing.

Engines have the timing location in the form of a line or dot marked on the rim of the vibration damper, crank pulley or flywheel with a pointer attached to the timing cover or flywheel cover with an inspection opening. When the timing mark is exactly against the pointer, the contact breaker points should open to create a spark in the number one cylinder.

Equipment:

1. A Single Cylinder 4-stroke Spark Ignition Engine or
2. A Multicylinder (4 cylinder) 4 stroke spark Ignition engine
3. Ignition Timing Stroboscope or Light.

Tools

1. Spark Plug spanner
2. Screw Driver
3. Feeler Gauge.

Procedure:

1. Disconnect all high tension wires
2. Remove distributor cap.
3. Remove spark plug of No. 1 cylinder.
4. Rotate crank shaft and make the timing mark on pulley or flywheel to coincide with the pointer; rotate the crank shaft until No. 1 cylinder piston is at top dead centre of the firing position. This can be ascertained by watching the valve action or holding a finger over spark plug hole to feel the compression. The ignition spark must occur at the top of compression stroke when the timing mark is in front of the pointer.
5. Note the direction of rotation of the rotor. The rotor will now point towards the No. 1 cylinder plug's cap terminal. (No. 1 cylinder plug wire is then attached to this terminal).
6. Adjust the distributor position so that the contact breaker points just start to open. Install the distributor unit and tighten the clamp screw.

7. Set the C.B. Point gap with the help of feeler gauge and screw driver to specification. (thumb rule C.B. Point gap = 1/2 spark plug gap)
Ensure that the spring loaded carbon is in position at the central terminal inside the distributor cap.

8. Install the distributor cap. Install No. 1 spark plug in position. Connect the H.T. wire between the spark plug and the terminal in front of the rotor (Ensure that plug is cleaned tested and the gap set as per specification)

9. Install the remaining High Tension wires as per Firing Order after No. 1 wire in the direction in which the rotor turns, e.g. for 1-3-4-2 firing order and rotor turning clockwise No, 3 wire should follow No. 1 in clockwise direction followed in order by 4-2 respectively.

10. Install the H.T. wire of Ignition coil in the central terminal of the distributor cap.

11. Connect the low tension wires of Ignition timing light across Battery Terminals. Connect the H.T. terminal to No. 1 cylinder's spark plug.

12. Disconnect the vacuum advance pipe at carburettor/ inlet manifold to prevent the vacuum advance mechanism from operating which would affect the

timing. Close the hole by taping to prevent engine from drawing air into the manifold.

13. Start the engine and adjust the idling speed (500 rpm or less). This is important to make sure that the mechanical advancing mechanism is not operating). Throw the Light from Timing light on the Timing Mark. Adjust the Distributor so that the mark coincides with the pointer. Adjustment of the Distributor is done by loosening the body holding nuts to the cylinder block and slightly rotating the body to make the timing marks coincide. After the adjustment the Distributor body is tightened in position.

Precautions

1. Before setting the ignition timing of an engine the engine manufacturer's specification should be referred to.

Evaluation

1. What is ignition timing ?
2. Why is it necessary for the spark to be delivered earlier in the cycle at higher speeds ?
3. What is the purpose of the centrifugal advance mechanism ?
4. What is the purpose of the vacuum advance mechanism ?

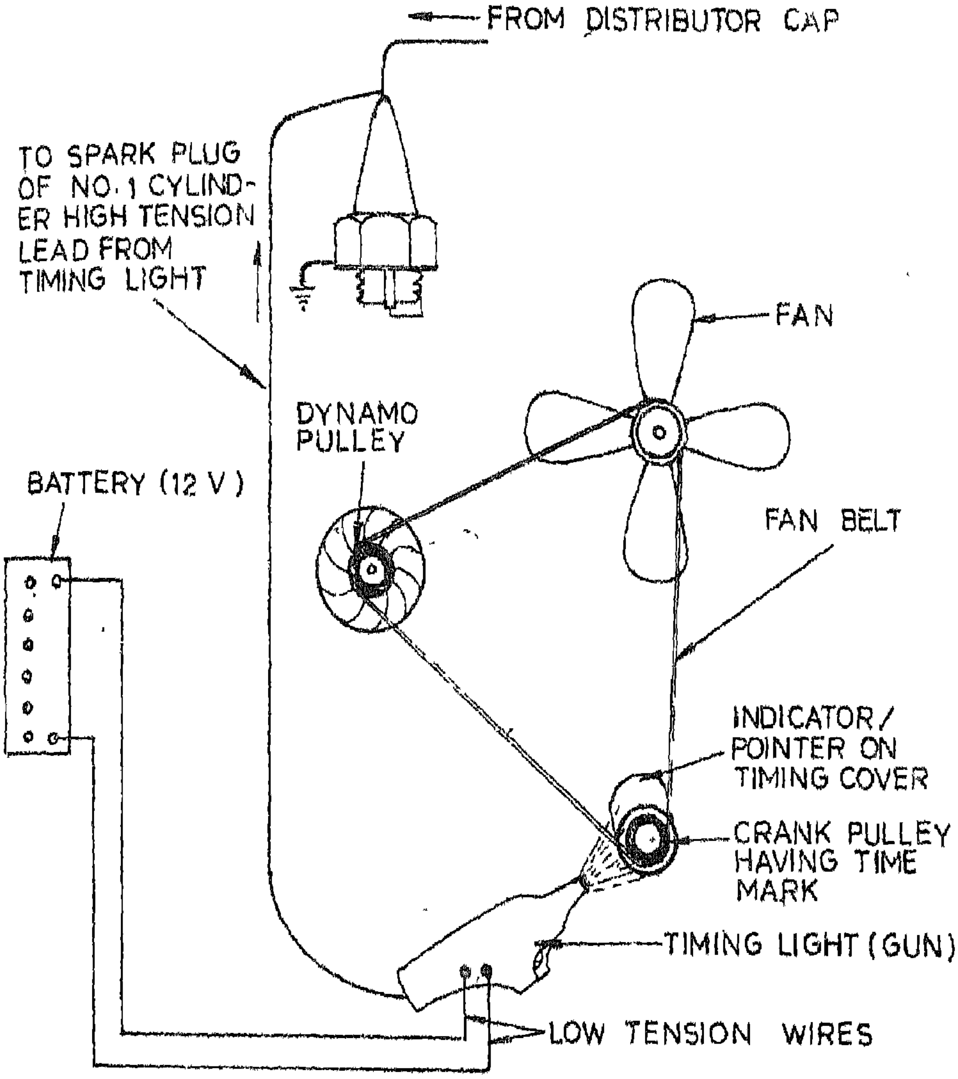

FROM DISTRIBUTOR CAP
TO SPARK PLUG OF NO. 1 CYLINDER HIGH TENSION LEAD FROM TIMING LIGHT
FAN
DYNAMO PULLEY
BATTERY (12 V)
FAN BELT
INDICATOR/ POINTER ON TIMING COVER
CRANK PULLEY HAVING TIME MARK
TIMING LIGHT (GUN)
LOW TENSION WIRES

FIG.-2·7·1 - CIRCUIT DIAGRAM

5. How does the vacuum advance mechanism function at idle ?

   At part throttle ? At full throttle ?

6. How is the ignition timing light connected to check the timing ?

7. What is the firing order for

   (i) a 4 cylinder inline engine?

   (ii) a 6 cylinder inline engine ?

   (iii) a V-8 engine ?

8. Where are the engine "timing marks" located ?

/TARA/

Experiment No. 3.1

General Objective : Study of Different Types of Air Cleaners.

Specific Objectives :

1. To know the constructional features of
   (a) Dry Type Air Cleaner
   (b) Wet Type Air Cleaner
2. To dis-assemble, inspect clean and re-assemble the air cleaner.

Introduction :

These are commonly used in all [illegible] vehicles. It pulls air down a passage way, forces it to make a sharp bend over a puddle of oil, back up through a mesh, and over and down into the carburettor. The air gains considerable speed as it travels down into the cleaner. When it makes the sharp bend, just above the oil, the heavier dust particles cannot make the corner and are slammed into the oil where they settle to the bottom. The wool like mesh stays wet with oil and cleans the air even more. This filter may be cleaned by changing the oil and flushing the element.

Equipment :

1. Oil Bath air cleaner
2. Dry type air cleaner
3. Kerosene for cleaning
4. Air under pressure
5. Cork gasket

Tools

1. Screw Driver
2. Plier
3. Set of double ended spanners.

(1) Constructional Features

Refer to figures 3.1.1, 3.1.2, and 3.1.3. these give the constructional features of the wet type and the dry type air cleaners.

In general an air cleaner consists of

(1) Housing
(2) Filter element
(3) Cover
(4) Arrangement for hose fitting
(5) Arrangement for fixing the cover on the housing.

The difference in the dry type and the wet type is that of the filter element.

A dry type air cleaner will have a paper element where as a wet type air cleaner will have a wire mesh type filter element.

In the oil bath (wet type) oil is placed upto the level indicated on the inner side of the housing.

Dis-assembly of Oil Bath Type Air Cleaner.

i) Unscrew the clip securing the air cleaner to the air intake pipe.

ii) Detach the rocker [illegible] ther pipe.

iii) Take out air cleaner from the engine.

iv) Remove wing nut from the centre bolt of the top cover and take out filter element which is one unit.

Inspection & Cleaning:

i) Examine the oil container for sludge:- If sludge is found, wash with Kerosene.

ii) Check cork gasket - if found faulty replace it

iii) Wash the filter element in a bowl of Kerosene, and allow it to drain and dry thoroughly.

Fill Oil Upto Correct Level.

and Assemble in Reverse Order

Dis-assembly of Dry Type Air Cleaner

1. Unscrew the clip securing the air cleaner to the air intake pipe.

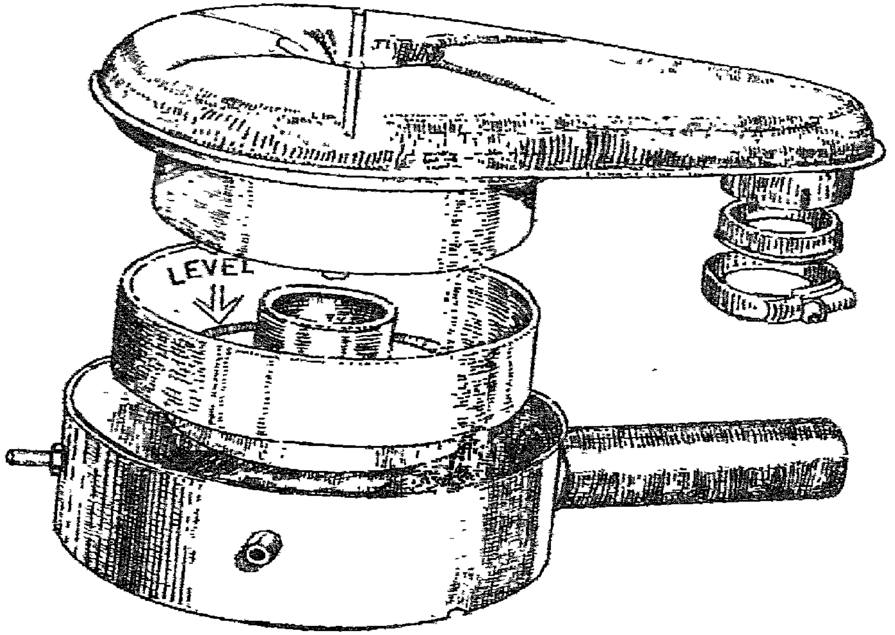
2. Take out air cleaner from the engine

3. Remove wing nut from the center bolt of the top cover and take out filter element which is one unit.

Inspection & Cleaning

1. Examine the filter element for dust clogging.
2. Use low pressure air for cleaning the filter element.
3. If the filter element is punctured, then replace it with a new one otherwise reuse it.
4. Place the filter element in the housing
5. Put the cover on top and tighten the wing nut
6. Air cleaner is ready for fitting on top of the carburettor or the intake pipe.

FIG. - 3.1.1 - THE COMPONENT PARTS OF THE AIR CLEANER



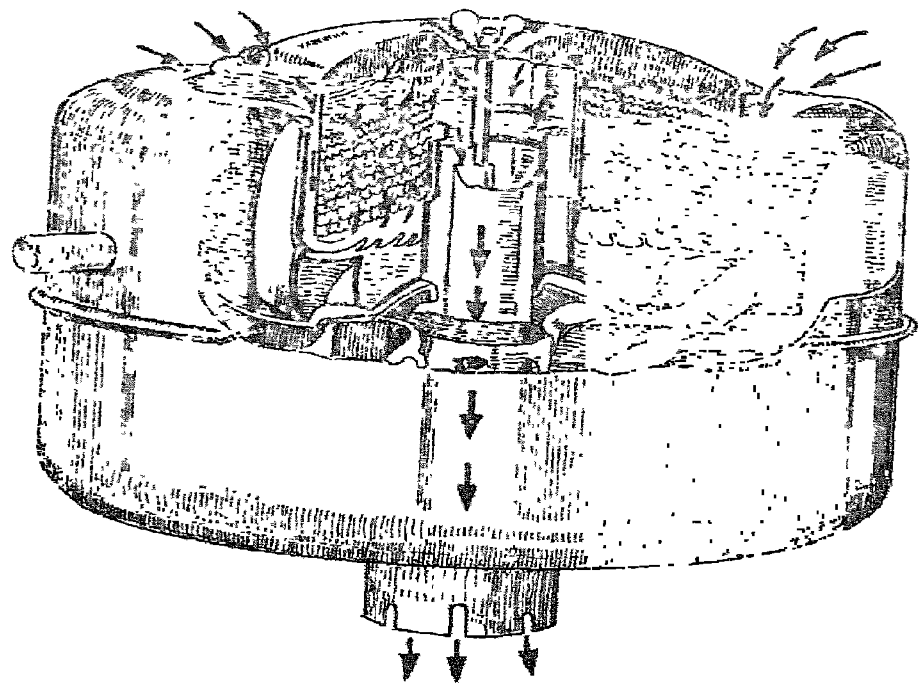


FIG. - 3·1·2 - A CUT AWAY SECTION OF OIL BATH TYPE AIR CLEANER

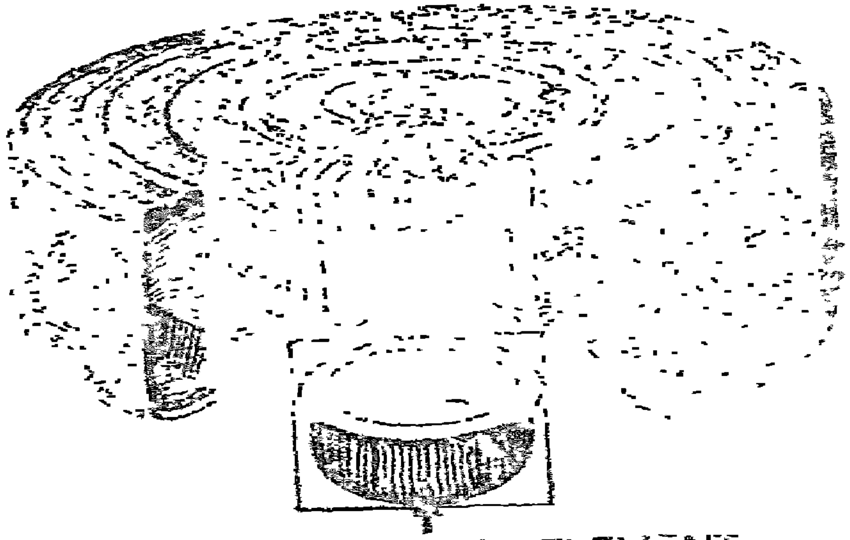


FIG-3.1.3

A DRY TYPE AIR FILTER ELEMENT CONTAINS POROUS FILTER PAPER TO TRAP THE DIRT

Precautions :

1. Never blow high pressure air for cleaning the filter element.
2. Do not reuse the old oil of the oil bath of the wet type air cleaner.
3. Do not allow the oil to touch the rubber gasket etc.
4. Rinse the wire mesh of the filter element thoroughly with kerosene.
5. Tighten the wing nut properly so that there is no leakage of air direct to the engine.

Evaluation Questions :

1. Why is an air cleaner a must for the engine?
2. What is the effect of a dirty air cleaner or a choked air cleaner on the performance of the engine?
3. What will happen to the fuel consumption if the air cleaner is dirty?
4. What is the effect of over filling of oil in the oil bath on the engine performance?
5. What is the effect of under filling of oil in the oil bath on the engine performance?
6. Will a punctured filter element of dry type air cleaner function efficiently?

Experiment No. 3.2

General Objective : Study of 'Fuel System'.

Special Objective :

1. To know construction and working of fuel pumps;
2. To know servicing of the Mechanical fuel pump.

Introduction :

It's main function is to supply fuel from the fuel tank to the Carburettor, there are two types of fuel systems.

a) Gravity Feed System

b) Forced Feed System

a) Gravity Feed System :- This type of Feed System is mostly used for two wheelers & three wheelers. In this type, fuel tank is placed above the level of carburettor and is connected to it with the help of pipe. Fuel flows to the carburettor due to gravity.

b) Forced Feed System :- This system is used for four wheelers and six wheelers etc.

In this type tank is placed at some convenient place and generally below the level of carburettor. To raise the fuel from low level and to feed to the carburettor, a fuel pump is used. The Pumps used for Fuel supply system are of two types :-

(i) Mechanical Fuel Pump

(ii) Electrical Fuel Pump

Equipment :-

1) Mechanical Fuel Pump

2) Electrical Fuel Pump

Tools required :-

1) Spanner set

2) Screw Driver

Construction and working of mechanical fuel pumps:-

Mechanical Fuel Pump

The constructional features of a Mechanical Fuel Pump used on the Indian car are shown in Fig.3.2.1

The to and fro movement of the diaphragm is responsible for the actuation of the inlet and outlet valves (These valves are one-way traffic and function in one direction only).

The spring No.6 keeps the diaphragm in the upward position if there is no pressure above the diaphragm and a positive contact is maintained between the two rockers (inner and outer). The movement of the outer rocker is is due to a pressurised contact between the rocker follower and the eccentric provided on the cam-shaft of the engine.

As the diaphragm is pulled down by the rocker, vacuum is created in the chamber above the diaphragm which opens the inlet valve and thereby fuel rushes inside the chamber. As the vacuum is killed due to flow of fuel, the inlet valve closes. Now when the diaphragm moves upward under the spring force the pressure in the top chamber increases and opens the outlet valve thereby forcing the fuel in to the float chamber of the carburettor. When the diaphragm is in the normal position, the rockers (inner and outer) have positive contact and the diaphragm gets pulled down due to the outer rocker movement and the supply continues till the fuel demand is [illegible] float chamber of the carburettor.

When the fuel demand is met that is, the needle valve is closed, the fuel in the top chamber will not get released and the diaphragm will not be in a position to move upward, because under the circumstances, the pressure on the outlet valve is more and will remain closed. Under these conditions the diaphragm remains in the lower position and there is no positive contact between the outer and inner rockers and the outer rocker keeps on having the free strokes without actuating the inner rocker.

Moment a demand is there from the carburettor, the needle valve opens the pressure in the fuel line above the outlet valve is released, this makes the outlet valve open and disphragm moves upward making the fuel supply in the line. As this happens, a positive contact between the rockers takes place and the pump starts supplying the fuel as described earlier.

Electric Fuel Pump

This fuel pump is used on some heavy duty equipment such as trucks. (It is also used on old models of Ambassador car) These pumps are similar to mechanical type, differ now being that of actuation, which is electrical. These pumps carry either diaphragm or a metallic bellow, but the working is similar.

Constructional Features (See Fig. 3.2.2

Sectional view of electric fuel pump

This pump carries a solenoid coil in its body, one end of which is connected to the battery through the ignition coil while the second end of the solenoid coil is earthed through contact points in the pump. When the ignition is switched on, solenoid col is energised and a magnetic field is set up. Due to this magnetic field a plunger moves which expands the bellows thereby creating a vacuum inside the bellows. This action opens the inlet valve and the fuel rushes inside the bellows. The plunger keeps on moving till the contacts get opened. Moment the contacts are open, the solenoid's magentic field is destroyed and the plunger stops further travel. As the vacuum in the bellows vanishes, the inlet valve closes. The return spring brings the bellows to the original position thereby increasing the pressure inside the bellows.

This results in opening of the outlet valve and supply of fuel to the carburettor. When the bellows [illegible] its expanded position, contact points close [illegible] and the solenoid coil is energised which [illegible] motion to the plunger and expansion of the bellows, [illegible] on. The system continues working till [illegible] is on and there is demand for [illegible]. If there is no demand [illegible] pressure in the fuel line will [illegible] not allowing the outlet valve to operate and this will result in keeping the bellows in the expanded position. In this position are contact points are open and the plunger remains stationary.

Moment the demand is received from the carburettor, the pressure in the fuel line above the outlet valve reduces, this allows the outlet valve open and release pressure inside the bellows. The return spring will bring the bellows to the collapsed position, making the plunger to bring the contact points in closed position thereby energising the solenoid coil and getting the bellows actuated electrically.

Dis-Assembly of Mechanical Fuel Pump

1. Disconnect the fuel lines, plug them and dismount the fuel pump from engine;
2. Clean the fuel pump externally;
3. Remove the body fixing screws to separate the upper body assembly from the lower body assembly;

4. Unscrew the lever housing assembly fixing screw;
5. Press down the diaphragm main assembly and pull out the lever housing assembly. Now the diaphragm main assembly can be taken away.
6. Unscrew upper body bracket assembly and take out filter chamber cover, gasket, filter spring and filter.
7. Remove valve plate assembly screws and pull out valve plate assembly.

Inspection And Cleaning/Repairing of The Components

1. Clean the filter in petrol, blow air to remove any clogging dust, and rinse again in petrol. Check the filter for any damage, if spoiled, replace it.
2. Check diaphragm for cracks, hardness, - if found with the above defect replace it otherwise reuse it.
3. Check diaphragm spring, the rocker spring, and filter spring for rust and physical damages like crack, breaking and narrowing near the ends. If damaged replace.
4. Check valve springs for deposits. If deposits are found replace the valve plate completely.
5. Check valve gasket for cracks etc. If damaged replace it.
6. Check filter chamber washer for damage. Replace, if damaged. Assemble all parts taking reverse order.

Fuel Pump Working Data

The fuel pumps are designed to operate at a pressure of 0.2 Kg/cm^2 to 0.25 Kg/cm^2. The inlet vacuum should be 17 to 18 cms of Mercury when the engine is running at 1800 rpm. Free delivery at idling speed (550 rpm) should be approx. [illegible] litre [illegible].

Testing of Fuel Pump

1. After the assembly of the fuel pump, connect the fuel pump testing gauge at the inlet [illegible] and operate the pump manually till the maximum reading is obtained on vacuum side. Observe if there is any movement of the indicating needle. If it drops, the inlet valve is leaking. Replace the valve plate with new packing.
2. Connect the fuel pump testing gauge to the delivery side of the pump of operate the pump manually till the max. reading of 0.2 to 0.25 Kg/cm^2 is reached; observe for any fall in pressure. If any change, replace the valve plate with new packing.

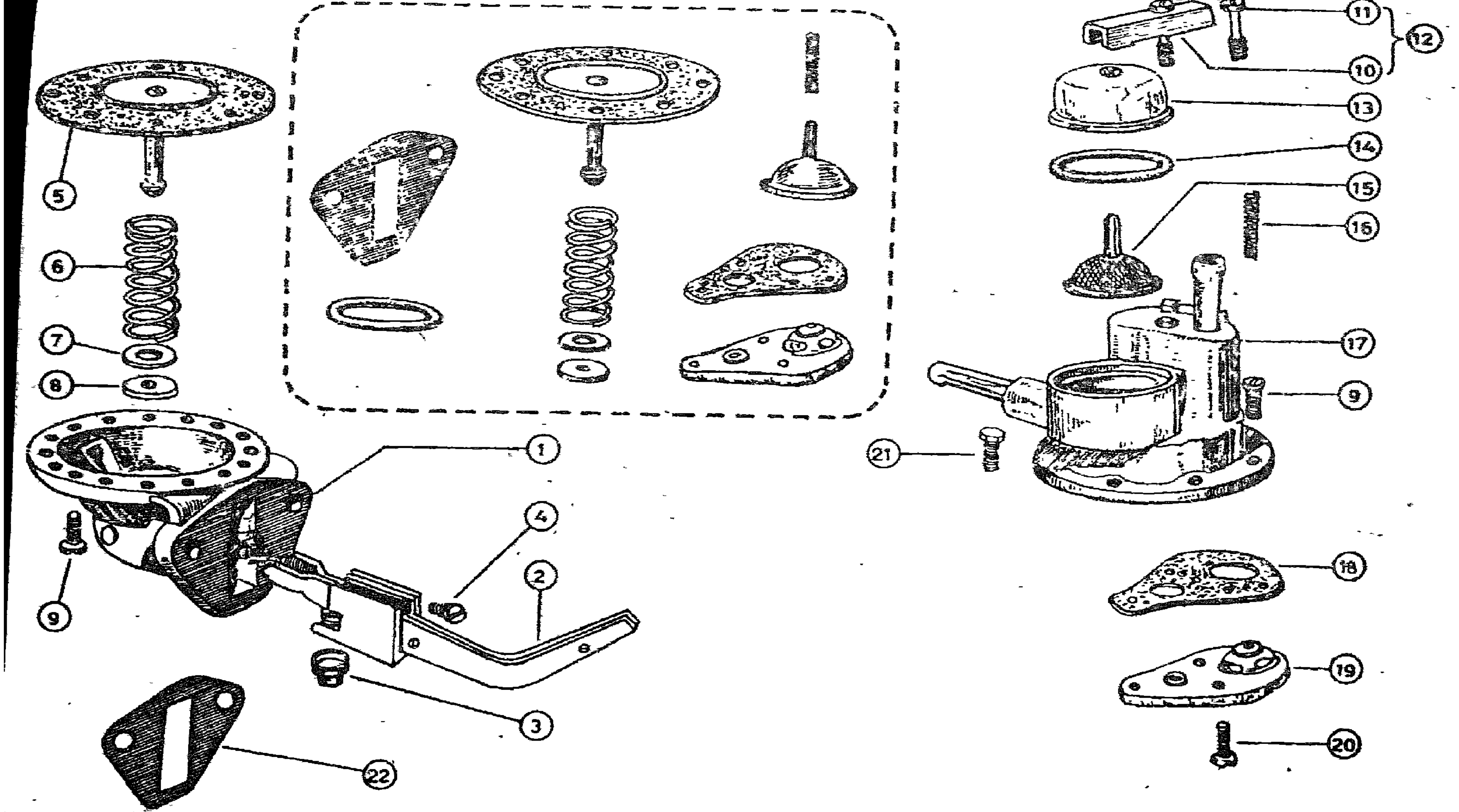
Fit the fuel pump on the engine with new gasket and run the engine at the idling speed. Observe the discharge for 5 minutes and find the average. If the supply is less, replace the diaphragm.

Few More Lines on Fuel Pump (Mechanism)

The fuel pump requires no particular attention. Nevertheless, a periodical check is recommended by taking off pump cover, the sludge deposited in fuel

/TARA/

IG.-3-2-1-CONSTRUCTIONAL FEATURES OF MECHANICAL FUEL PUMP



IBEX FUEL PUMP PARTS

Fig. 3.2.1. CONSTRUCTIONAL FEATURES OF MECHANICAL FUEL PUMP

1. Lower body
2. Lever housing assembly complete
3. Spring from main lever
4. Lever housing fixing screw
5. Diaphragm assembly
6. Diaphragm spring
7. Metallic washer
8. Sealing washer
9. Screw
10. Bracket
11. Bracket fixing screw
12. Brakcet assembly
13. Filter chamber cover
14. Washer for filter chamber cover
15. Filter
16. Spring for filter
17. Upper body assembly
18. Washer for valve plate assembly
19. Valve plate assembly
20. Valve plate fixing screw
21. Body fixing screw
22. Flange gasket.

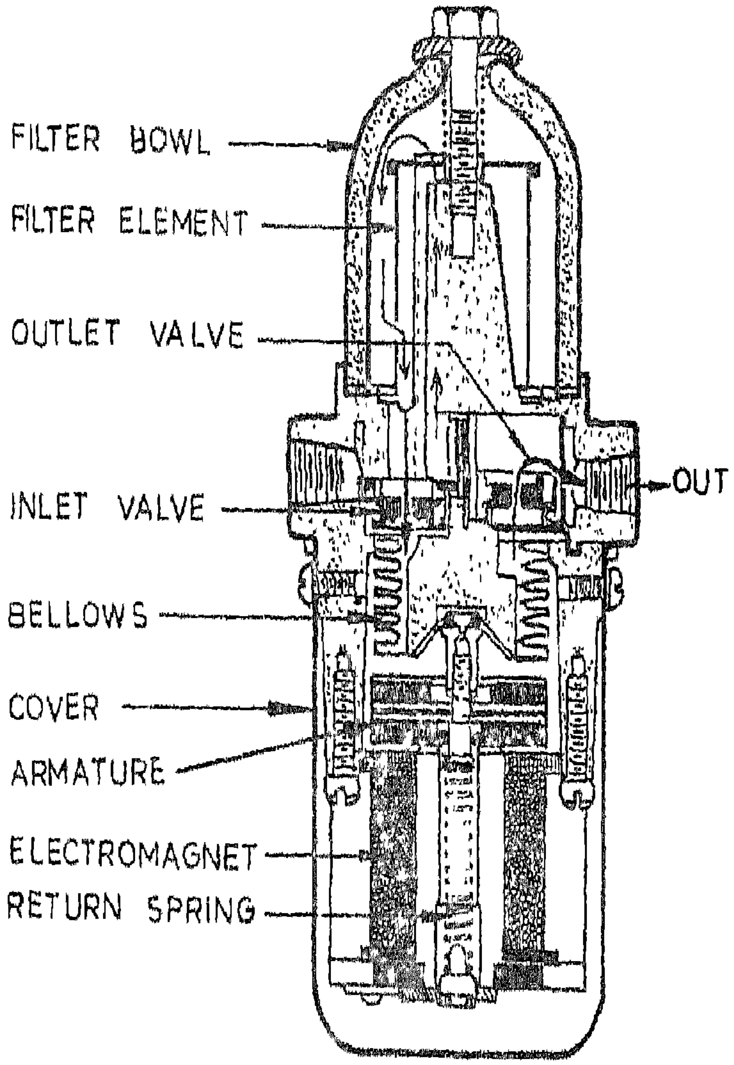


FIG-3.2.2 SECTIONAL VIEW OF ELECTRIC FUEL PUMP

chamber or on filter screen may be removed. The inlet chamber diaphragm control mechanism must be washed in kerosene and wetted with some thin oil.

Fuel pump seals, even if lightly damaged, must be replaced. Apply grease sparingly on new seals before assembly. If a new diaphragm has to be fitted, keep it in kerosene for at least fifteen minutes before assembly. (NOTE : Periodical checks should be done after 6000 kms. and diaphragm and gaskets to be replaced after every 20,000 kms).

6. Evaluation Questions

1. What will happen if the diaphragm is not properly fitted?
2. What will happen if the main spring loading the diaphragm is not properly seated ?
3. Why the rocker arm of mechanical fuel pump consists of two links ?
4. What is the function of the rocker arm spring ?
5. What will happen if a non specified mechanical fuel pump is fitted on to the vehicle ?
6. How will you remove the vapour lock in the fuel pump ?
7. Explain the working principle of the mechanical fuel pump ?
8. What is the advantage of Electric Fuel Pump over the Mechanical Fuel Pump.
9. What is the range of pressure at which fuel pump operates ?
10. After how much distance, the periodical check of fuel pump should be made ?

Experiment No. 4.1.1

General Objective

Study of Engine Tune up Techniques.

Specific Objectives

To perform the tune-up of various major engine units of a 4-stroke cycle engine.

Introduction

Engine Tune-up is one of the most important of all service operations. Tune-up is defined as "To make the necessary adjustments, especially, the FINER adjustments which are necessary to bring an automobile engine into a FIRST- CLASS running condition."

It may be noted that finer adjustments cannot be made to an engine when important defects exist in the cooling, lubrication and other systems. Therefore, a tune-up should not be attempted on an engine having leaking piston rings or valves; [illegible] or loose bearings; or defective radiator or water pump. With faulty cooling lubricating or exhaust systems proper results just simply cannot be obtained.

The major engine systems which require tune-up are the Engine ignition and electrical system and fuel system.

Engine Tune-up includes testing the various components and accessory systems involved in engine operation. Tune-up goes farther than more testing, however. It also includes re-adjusting or replacing parts as required to restore new engine performance. In some cases, during a tune-up, serious troubles may be uncovered that will require major repair work.

Equipment

1. Engine (to be tuned) on vehicle.
2. Compression gauge
3. Spark Plug Tester

Tools

1. Feeler gauge
2. Screw drivers
3. Ring spanner set
4. Double ended spanner
5. Spark Plug Spanner
6. Toppet adjusting Tool - Special Tool
7. Spark Plug gap adjusting Tool - Special tool.

Experiment No. 4-1-2

TAPPET ADJUSTMENT

The adjustment is done in cold as well as hot conditions.

a. Adjustment under cold conditions

1. Remove tappet cover

2. Remove spark plugs

3. Crank the engine with handle and bring the piston of cylinder No. 1 to top dead centre position (TDC) in compression stroke.

4. Check the clearance at the tappets of inlet and Exhaust valves with a feeler gauge and adjust these with the recommended values supplied by the manufacturer.

5. Observe the same procedure for cylinder No. 2,3 & 4 by bringing the piston of the respective cylinder to TDC positions in compression stroke.

b. Adjustment under hot conditions.

1. Run the engine for sufficient time till a sustained working temperature is obtained (80 to 85 deg. C)

2. Stop the engine and remove the tappet cover and the spark plugs.

3. Observe the same procedure for checking and adjusting the tappet clearance as used for cold condition.

Recommended Valve clearances

1. Premier

Tappet clearnace Inlet/Exhaust valves = 0.010"

(0.254 mm)

ii) Ambassador

Tappet clearance Inlet/Exhaust valves = 0.015"

(0.381 mm)

Experiment No. 4.1.3

Ignition System Tune up

The following units are to be checked.

1. IGNITION COIL
2. SPARK PLUGS
3. DISTRIBUTOR
   - (i) Distributor cap
   - (ii) Distributor H.T. Leads
   - (iii) Condenser

(iv) Rotor

(v) C.B. Point

(vi) Centrifugal Advance

(vii) Distributor cam shaft

This experiment involves the following:

1. Dis-assembly of the ignition system components.
2. Testing of the various components.

1. Dis - Assembly

i) Remove the distributor cap along with the leads.

ii) Take out rotor from the shaft.

iii) Remove the C.B.Point base plate along with condenser and terminal by removing screws.

iv) Remove vacuum advance mechanism if fitted.

v) Dismount C.B. Point and condenser from the base plate.

vi) Clean all parts with brush using petrol.

2. Testing of various components

i) Ignition Coil

Inspect the bakelite insulation on top of ignition coil for cracks and test the Coil on Coil Test Bench for proper sparking capability. If found defective, replace it. (Precaution Observe polarity for battery and C.B. Point connections).

ii) Spark Plug

1. Remove the sparkplug from the engine and inspect for the colour of the electrode.

  a) Oily and black indicates extra oil consumption
  b) black indicates rich mixture
  c) brown indicates spark plug is O.K.
  d) white indicates over heating.

Clean the spark Plug with a scraper, wash in petrol and sand blast.

Set the correct gap and test it on spark plug tester.

If the spark is obtained under high pressure (75-80 psi), it can be used, otherwise replace it.

(N.B. the life of a spark plug normally is around 15000 km.)

Distributor

i) Check all the H.T. leads for cracks. If spoiled, replace.

ii) Check the distributor cap for visual cracks, and subject it to H.T. test for hair-line cracks etc. It defective, replace it.

iii) Check the spring loaded carbon in the cap for its free movement. If sticky or spring is worn, replace.

iv) Check C.B. Point for pitting, wear and tear etc. It spoiled, replace.

v) Check condenser on test bench. If defective replace.

vi) Check centrifugal retard-advance weights for free lateral movement and broken springs. If lateral movement is hard, lubricate the system and if the springs are broken, replace.

vii) Check main-shaft clearance in the housing by giving side motion, if there is excessive play, replace the shaft or bush.

viii) Check cam cobes for wear etc. If rounded, replace the cam assembly.

ix) Check vacuum advance mechanism if fitted; by sucking air through the pipe connection. It should hold vaccum. If faulty, replace the unit completely.

x) Assemble the distributor by taking steps in reverse order.

xi) Adjust C.B.Point gap according to the specifications by keeping the fibre of the moving link on top of the labe.

Experiment No. 4.1.4

Fuel system Tuneup

This involves the cleaning and overhauling of the two major components of the fuel system namely.

a) Air cleaner

b) Carburettor

A) AIR CLEANER (OVERHAUL)

1. Dismount the air cleaner from the carburettor by loosening the clamp.
2. Unscrew the butterfly nut and remove the top cover.
3. Remove the filter element and clean in kerosene and blow with air.
4. Remove the oil, clean the sump with kerosene.
5. Replace the top and bottom gaskets.
6. Replace the rubber mounting
7. Assemble the unit taking steps in reverse order.

B) CARBURETTOR (OVERHAUL)

1. Remove the air cleaner from top of carburettor.
2. Remove the carburettor from the engine body by disconnecting the control linkage (accelerator and choke) and fuel supply line.
3. Open the top cover and clean the carburettor.

4. Make sure that all the jets are of proper specifications.
5. Assemble the unit by using new washers.
6. Fit the carburettor on the inlet manifold and make all the control connections including fuel line.
7. Mount the cleaned air cleaner on top of the carburettor and tighten the clamp.
8. Run the engine and warm it up.
9. Race the engine by throttle adjustment(speed around 600 rpm)
10. Adjust the idling screw to get the maximum speed.
11. Adjust the throttle to get the idling speed (500 rpm or as recommended)

Precaution:- Before the Carburettor is tuned make sure that the Ignition circuit is correctly connected.

/TARA/

Experiment No. 4.2

Specific objective:

Tune up of the major engine components of a 2 stroke cycle engine.

A. AIR - FUEL SYSTEM

AIR FILTER

Take out Air filter from air intake-box by removing the clamp securing to the air in-take box and the hose clip securing the rubber bellows to the Carburettor. Take out filter Cartridge. The filter insert is cleaned by shaking it and blowing low pressure dry compressed air from the inside of the cartridge.

NOTE: Air filter should not be cleaned with petrol, water or oil.

Refit Air filter with rubber hose connections properly.

CARBURETTOR

Take out carburettor from engine, Clean it with cleaning-solvent. Clean passages & jets with compressed air. Do not use wire for cleaning jets & passages.

Check float, float level and valve seat. Needle, slide & jets for proper working; if any of above are damaged or worn out; replace. Assemble carburettor and refit it on engine intake manifold.

Precautions:-

There should not be any leakage between air cleaner & carburettor inlet port.

B. IGNITION SYSTEM

SPARK PLUG Take out spark plug, check to ensure it is of the correct type (as per manufacturer's recommendation); Clean electrodes with cleaning tool and adjust the gap as per instruction manual. In general it should be between 0.4 to 0.5 mm. Check C.B. Points for proper working; if it is pitty, clean it with oil stone for emery paper then adjust C.B. point gap. It should be adjusted as per instruction mannual. In general the gap is adjusted between 0.3 to 0.4 mm. The opening of C.B. point should start at a point when the piston has a 4 mm. travel before T.D.C.

NOTE:- If the C.B. Point is pitted, replace it.

CONDENSER

The condenser in the ignition circuit which appears to be a simple component has a very vital function to perform and hence should be checked carefully. A weak condenser or short circuited condenser will either make the spark weak or provide no spark at all in the spark plug. Hence with a faulty condenser, the consumption of petrol will increase, Spark plug will get spoiled faster, increase in carbon deposition which in turn will spoil the piston rings and suffocate the exhaust ports. Hence the importance of the tiny condenser.

Remove condenser from the vehicle and test it on the test bench for:

(1) Insulation breakdown
(ii) Low insulation resistance
(iii) High series resistance
(iv) Capacity.

(i) Breakdown is a failure of the insulating material, causing a direct short between the metallic elements of condensor.

(ii) Low insulation resistance or leakage prevents the condenser from holding a charge. A condenser with low insulation resistance is said to be "weak".

(iii) High series resistance is excessive resistance in the circuit due to broken strands in the condenser lead or due to defective connection.

(iv) The capacity of a condenser is determined by the quantity of electrical charge it can hold for a given electrical pressure. The capacity is measure in microfarads. For scooters the capacity is about 0.27 microfarad (range 0.25 to 0.28)

If the condenser capacity is too low, arcing across the points will be excessive because of the inability of the condenser to absorb sufficient electrical energy at the time the contacts separate and a pit will be formed in the negative contact.

If the condenser capacity is too high the pit will form in the positive contact with a correspon-ding build-up on the negative contact.

In case the condenser tester is not available in the shop, then a good discharge of the condenser with a 12v battery charging will give sufficient clue about its working condition.

It there is no discharge, replace it. Check H.T. lead; if broken replace it.

/TARA/

Experiment No 4.3 ; General Objective : To study the engine Compression test.

INTRODUCTION:

Engine compression Test

Two types of tests are possible

1. Dry compression test
2. Wet test

1. Dry compression test. To be carried out when the engine is at operating temperature and battery in fully charged condition.

The engine should be run for 15-20 minutes before conducting the test.

1 Remove all spark plugs
2. Remove air cleaner
3 Keep the throttle fully open
4. Check the lubricating oil for proper grade.
5. Connect the compression gauge to No.1 cylinder spark plug hole
6 Crank the engine withself starter for about 10 seconds till maximum reading is reached in the gauge.
7 Check the compression pressure in all the cylinders by connecting the compression guage to each cylinder in turn.

Observations and Inferences

1. The observed pressure should be within 10% of the recommended value of the manufacturer e.g. If the recommended pressure is 130 psi, then the reading on the compressure gauge should not be less than 117 psi.

In case it is less, it indicates

i) Leaky valve seats.
ii) Leaky gasket
iii) Worn-out piston rings.

If two adjacent cylinders give same (lower) compression pressure than the desired value then the inference is that the gasket between the two cylinders giving lower pressure is damaged. Damage of the gasket is further confirmed by the appearance of bubbles in the radiator water.

2. Wet Test

Put measured quantity (10 ml) of lubricating oil in each cylinder through the opening of the spark plug holes and crank the engine for 10 seconds. Recheck the compression pressure in each cylinder.

1. If a rise in pressure is indicated the inference is tha the particular cylinder showing the rise in pressure is havi worn-out rings.
2. If there is no rise in pressure in the cylinder, this indicates that the valves are faulty.

Necessary adjustments or repairs may be conducted acco

COMPRESSION TEST

Observation Table

Name of Student:

Name of engine:

Specified compression pressure: psi or Kg/cm^2

CYLINDER NO.	DRY TEST psi/kg/cm^2	WET TEST psi or kg/cm^2	Vairation
1			
2			
3			
4			
5			

INTERPRETATION

/TARA/

Experiment No. 5.1

General Objective : Study of the Carburettor

Specific Objectives :

1. To know construction and working of carburettors (Solex and IBEX)
2. To know various circuits of fuel flow.
3. To know servicing of carburettor.

Introduction

The Internal combustion engine is quite sensitive to the ratio of fuel to air in the mixture which is supplied to its cylinder and it is the function of the carburettor to maintain this ratio at or near the correct value. The optimum is about 15 parts (by weight) of air to 1 part of petrol, and in this mixture the amount of oxygen present is just sufficient to burn the petrol completely. It might be thought that the excess of air in a weak mixture would be advantageous in ensuring complete combustion but any oxygen remaining in the exhaust gases tends to combine with other materials causing erosion of exhaust valves etc. and hot running. On the other hand the incomplete burning of the petrol in a rich mixture leads to rapid build-up of carbon deposits. Under normal running the A/F ratio varies between 12:1 and 19:1. This variable demand of A/F ratio depending upon the speed and load conditions, is taken care of by the device Carburettor, the sc called heart of the vehicle. To fulfill this variable demand, the carburettor in general performs the following functions.

1. Supply of rich mixture when engine is cold at the time of starting.
2. Correction to the supply of fuel when engine gets heated up.
3. Supply of correct quantity of fuel at idle speed.
4. Supply of sufficient fuel while driving on hills or the vehicle taking heavy load.
5. Response to sudden acceleration and supply of rich mixture.

To meet these requirements the carburettor is provided with following circuits, which we shall be studying in this experiment in detail.

1. Float circuit
2. Idling circuit
3. Slow speed circuit
4. High speed circuit
5. Choke circuit
6. Accelerating circuit

a. Equipment :

1. Solex Carburettor,
2. IBEX Side Draught Carburettor,
3. Compressor with hose pipe/Inflating pump.

b. Tools :

1. Screw Drivers of various sizes.
2. Spanner set
3. Combination Plier
4. Cleaning solvent and cloth
5. Cleaning Tray
6. Emery paper, Emory paste and glass plate
7. Compressed air
8. Cleaning brush.

Construction Working and Servicing :

Solex Carburettor

Refer Fig. 5.1.1. and 5.1.2. Fig. 5.1.3

F. - FLOAT

P. - NEEDLE VALVE

1. Filter Cover Nut
2. Copper Sealing washer
3. Fine Filter
4. Fibre washer
5. Float Toggle

Bistarter System (Fig No. 5.1.4.)

1. Starter air jet
2. Starter Disc Valve
3. Mixture Passage
4. Petrol Supply

Idling System (Fig. No. 5.1.5.)

1. Pilot jet
2. Volume control screw
3. Pilot air bleed
4. Throttle butterfly valve
5. Main jet
6. By - Pass orifice

Main Supply System (Fig. No. 5.1.6.)

1. Main jet
2. Air Correction jet
3. Emulsion tube
4. Spraying Nozzle
5. Throttle butterfly

Accetrator pump system (Fig. No. 5.1.7.)

1. Pump jet
2. Pump Injector
3. Diaphragm assembly
4. Pump Control rod nut.

Servicing of Solex Carburettor

Circuit No. 1 FLOAT CIRCUIT

Function : To control the flow of fuel to the float chamber and to maintain a correct specified level and to be a reservoir for the supply of fuel of the various circuits. (Refer Fig. No. 5.1.3)

Part No.	Name
F	Float
P	Needle valve

1. Filter Cover Nut
2. Fine Filter
3. Copper sealing washer
4. Fibre washer
5. Float toggle

DIS-ASSEMBLY

1. Remove the top plate and take out along with it the Needle valve, Filter and Filter plug. Take out the Float from the Float chamber.
2. Remove the filter plug and take out the filter, clean it, and fit it back.
3. Inspect the needle valve for wear and tear, stickness and proper seating. This is done by closing the needle valve manually and blowing the air.
   If, any wear, tear etc. is there, leakage may be observed. If no leakage valve is O.K.
   Otherwise replace it.
4. Check Float for puncture.
   Dip the float in hot water
   If bubbles appears, it is punctured replace it.
   If no bubbles, it is O.K.

Precaution

(i) No attempt should be made to repair the float by way of servicing. This will increase the weight of the float as well as unbalance it which will result in over flow of fuel in the chamber thereby increasing fuel consumption.

(ii) If dents occur on the float, put in the boiling water. If it get straightened than reuse it otherwise replace. (This is possible only when dents are large in size).

5. Blow the air vent in the top plate with pressurised air and check for clear flow of air.
6. Replace the gasket with the top plate.
7. Remove foreign particles, if any' from the float chamber.
8. Adjust the Fuel Level in Float chamber by adjusting Float Toggle.

CIRCUIT No. 2 CHOKE CIRCUIT /BISTARTER CIRCUIT.

Function : To supply rich mixture for cold starting. (Fuel does not vaporise fully at low temperatures thereby does not mix up properly with air in fine particles. To make sure that fuel particles are fairly distributed with air, more amount of fuel is required hence the rich mixture for cold starting).

(Ref. Fig. No. 5.1.4.)

1. Starter air jet
2. Starter disc valve
3. Spring for loading the disc.
4. Cover along with operating lever.
5. Control cable (inner and outer).

OPERATION :

When the lever is operated, the starter disc valve rotates. The rotation is controlled by the dash board control (Choke) by means of a lever and a cable. The starting device has two different drilling holes. One hole is for rich starting mixture, while the other is for a weaker starting and idling mixture.

DIS-ASSEMBLING :

1. Remove screws to disconnect the choke assembly from the main body.
2. Open the nut of the control lever from the choke assembly and dismantle the lever, spring and the choke disc alongwith the rod, and inspect the disc surface for proper lap and spring for proper compression, and the rod and link-hole for play.
3. Repair the disc to obtain even surface, change the spring for low compression, and replace the link for the large hole size if required. (Refacing is done by lapping the disc on the glass surface applied with fine emery paste).

4. Blow pressurised air in the passages for air, fuel and mixture for removal of any foreign particles before assembly.
5. Assemble the unit by following steps in reverse order.

CIRCUIT [illegible] IDLING SLOW SPEED CIRCUIT (Fig. [illegible].7.5).

Function : To supply A/F mixture to keep the engine running at idle speed (550 to 600 rpm) with accelerator in free position. (Throttle butterfly valve fully closed)

Parts

1. Pilot jet
2. Vacuum Control Screw
3. Pilot air bleed
4. Throttle butterfly valve.
5. Main jet
6. By-Pass orifice

DIS-ASSEMBLY

1. Remove all the three jets mentioned above and the pilot air bleed screw.
2. Clean all jets with cleaning solvent (Paraffin, petrol etc.)
3. Blow air in passages of main body and jets and assure the proper cleaning.
4. Check all the fibre washers. If these are serviceable reuse otherwise replace them.

5. Inspect the pilot air bleed screw for carbon deposition and clean if necessary with smooth emery paper (Zero Grade).
6. Inspect butterfly valve shaft for worn out condition at the body ends. Replace the wornout butterfly valve shaft by next lower size.
7. Inspect all jets for the recommended size to get economic performance.
8. Assemble all the parts by taking steps in reverse order.

SLOW SPEED CIRCUIT

Slow speed circuit is same as that of idle speed circuit. The air/fuel mixture is supplemented by one small passage connected to idle speed passage when the throttle valve is just opened.

(speed 750 to 850 rpm)

CIRCUIT NO. 4 HIGH SPEED CIRCUIT

Function : To supply sufficient A/F mixture to keep the vehicle running at high speed under loaded/unloaded conditions.

OPERATION :

With the butterfly valve having its opening further from the slow speed System the ventury effect becomes great enough to draw fuel from the main fuel jet. Fuel from the slow speed circuit starts tapering off as the amount from the main fuel jet increases and ultimately the slow speed system stops functioning completely when the butterfly valve is fully opened and vacurm at the slow speed holes is not enough to drop fuel in the slow speed passage.

(Ref. Fig. No. 5.1.6.)

PARTS

1. Main jet
2. Air correction jet
3. Emulsion Tube
4. Spraying Nozzle
5. Throttle butterfly

DIS-ASSEMBLY OF HIGH SPEED CIRCUIT

1. Remove air correction jet.
2. Pull out Emulsion Tube.
3. Remove Main jet.
4. Clean all the parts with cleaning solvent and inspect for any clogging and damage of the parts.
5. Blow air for removal of any foreign particles in all the parts. Replace damaged/wornout parts and assemble the parts in reverse order.

CIRCUIT NO. 5 ACCELERATION CIRCUIT (OPTIONAL)

When the butterfly valve is opened quickly to produce rapid acceleration of the engine, the mixture as supplied by the carburettor tends to become too lean and that is known as "flat spot" results. To supply the additional fuel to overcome this condition, a small pump is incorporated into the design of the carburettor.

(ref. Fig. No. 5.1.7)

PARTS

1. Pump jet
2. Pump Injector
3. Diaphragm Assembly
4. Pump Control rod nut
5. Spray nozzle.

DIS-ASSEMBLY

1. Remove pump Control rod from Carburettor throttle rod by removing the lock.
   (No attempt should be made to open the [illegible] nut. On the pump control rod, otherwise the adjustment will be altered).
2. Remove four screws from acceleration pump body and detach it from the carburettor body.
3. Remove screw to take out the spray nozzle (refer Fig. 5.1.5).
4. Remove Pump jet
5. Remove Pump Injector.
6. Inspect diaphragm for cracks and flexibility.
   (It should not be hard).

7. Inspect spring loading on the diaphragm for serviceability. In case broken, replace spring along with diaphragm.
8. Blow spray nozzle with compressed air to remove foreign particles. Check gasket.
9. Inspect ball non-return valve of the pump injector for leakage by placing the ball in its seat and blowing air with mouth. No leakage, then O.K. otherwise replace it.
10. Clean pump jet with cleaning solvent, blow with compressed air.
11. Assemble the whole sub-assembly by taking steps in reverse order.

IBEX CARBURETTOR

Ibex Side Draught Carburettor is used for Lambretta/Lamby/Vijai Deluxe/Suvega/Moped/Hero Majestic/Sujata/Atlas.

(Refer Fig. No. 5.1.8 Exploded view:

This type of carburettor consists of four main systems as follows :

1. Float system
2. Starter System
3. Slow Speed system
4. Main jet system.

1. Float System :

The float system regulates the level of fuel in the float chamber of the carburettor. If the level is not maintained correctly, it will affect smooth engine performance. A significantly lower level will result in a flat spot or starvation and a significantly higher level in excessive fuel consumption and also flooding. A **higher** float level may also be one of the causes of starting troble.

This system operates with a needle valve (N) controlled by a float (F) (Ref. Fig. 5.1.9). The correct level of fuel in the float chamber depends on the weight of float, height of needle valve and the thickness of the fibre washer. These components are manufactured from special materials and calibrated to close specifications. A filter is provided on the fuel inlet side to take care of fine grit of dust in fuel entering the float chamber.

STARTER SYSTEM (CHOKE SYSTEM)

As we know, only the highly volatile fractions of petrol vapourise under cold conditions. As such an extra supply of fuel is required to be mixed with air entering the engine so that the actual air-fuel mixture in the combustion chamber can be ignited by the spark.

The starter system permits the flow of a richer mixture to assist easy starting under cold conditions. To operate this system, a choke knob is operated. While starting, the accelerator is not touched. After the engine starts and gets warmed up the system should be disengaged.

FUNCTION : (Ref. Fig. 5.1.10).

When the choke knob is in operation, the starter slide(s) attached to the cable is lifted up and both air and fuel passages are subjected to engine suction. The air drawn through air circuit (SD) atomises the fuel drawn up through starter diffuser. This atomised fuel and air drawn through the air circuit (A) are emulsified and discharged through starter discharge here.

SLOW SPEED SYSTEM

The engine normally requires a relatively richer mixture at slow speed compared to what it would require under normal running conditions,. The slow speed system consists of an idling system and a By-pass system. The idling system functions when the throttle slide is practically closed.

By-Pass system functions when the throttle slide is slightly opened.

It is for general information that there is a slight difference from engine to engine in the requirements of idling mixture and this changes with the age and engine parameters like ignition timing, compression pressure etc. An air volume control screw takes care of these parameters.

(A) IDLING CIRCUIT (Ref. Fig. 5.1.9, 5.1.11, 5.1.12)

Suction of engine draws fuel through the pilot jet via main jet (MS.) main Diffuser (D) and the connecting cross hole (CH.) Air is also drawn simultaneously to pilot jet through air passage (AV) via pilot air bleed (PAB). The mixture gets discharged through the pilot discharge orifice. The air-fuel mixture ratio is controlled by a taper tipped Air volume control screw (AVCS) which controls the supply of air only. The minimum opening of the throttle slide required for rolling speed is controlled by the slow running adjustment screw. (SRA).

BY-PASS SYSTEM (Ref. Fig. 5.1.9, 5.1.11 and 5.1.12)

By-pass orifice (BP) is situated in the body under the slide. A depression created under the slide draws the air and fuel in the same manner as explained under idling with the addition that mixture comes through the by-pass orifice also.

MAIN JET SYSTEM

The main jet system takes care of mixture ratios required for maximum power and fuel economy at high speeds,

(Ref. Fig. 5.1.9 and 5.1.13)

As soon as the slide is opened, velocity of air in the carburettor bore under the slide begins to rise and creates depression (suction) over the main diffuser discharge hole (DH). The air drawn through main air bleed (MA) atomises the fuel drawn up through the mainjet (MS) into the main diffuser (D) and ultimately in the bore of the carburettor.

Servicing of IBEX Carburettor

Dismantling of the Carburettor

1. Loosen the air bellows fixing clamp and disconnect the air bellows from the carburettor.
2. Remove the air filter security clip and take out the air cleaner with bellows.
3. Disconnect the choke cable assembly by loosening the starter adaptor. Also disconnect the accelerator cable.
4. Remove the carburettor from Intake manifold of engine by loosening the clamp screw.
5. Remove top cover screws and take out top cover along with spring of slider.
6. Remove float chamber cover screw and take out float chamber and filter.
7. Remove all jets like main jet, pilot jet etc.
8. Disconnect the starter slide, spring and adaptor

from intake cable.

Inspection & Cleaning :

1. Inspect all jets and fuel passages. - Clean by compressed air and cleaning solvent. If any part found faulty, replace it.

NOTE : Never use wire for cleaning [illegible] and fuel passages.

Assemble in proper reverse order [illegible], [illegible] necessary gaskets, washers and replacement parts.

Identification of Various Components

OBSERVATION SHEET (For students)

S.NO. 666	Name of the part	Material Composition if it is an alloy	Purpose	Remarks/ Precaution
1.	Float			
2.	Slide			
3.	Body			
4.	Jet			
5.	Gaskets, packings & Washers screws etc.			

CARBURETTOR TROUBLESHOOTING (GENERAL)

I. Flooding of Carburettor

Causes	Remedies
i. Excessive fuel pressure by Fuel Pump	i. Give thicker packing between pump body & block
ii. Float level set high	ii. Adjust float level correctly
iii. Puncture float	iii. Replace
iv. Restricted movement of float lever.	iv. Straighten lever if bent see that float movement is free on pin.
v. Worn out or broken gasket.	v. Replace
vi. Loose, worn out or pitted seat of needle valve	vi. Replace valve seat.
vii. Dirty valve seat.	vii. Clean
viii. Loose main jet	viii. Tighten.

II. Low speed or Idle speed circuit sending less fuel

i. Blocked metering hole	i. Clean the passage
ii. Blocked economiser hole, pilot jet, idle passage	ii. Clean
iii. Torn out gasket	iii. Replace
iv. Any connection of intake manifold leakage	iv. Replace or tight.

III. Rich mixture on Idle or Slow Speed

i. Use of bigger size of jet or jet hole gone bigger.	i. Use correct jet or Replace jet
ii. Restricted passage of by-pass	ii. Clean
iii. Worn out threads of idling screw	iii. Replace it, in case of body, threads spoiled repair.
iv. Worn fitting of throttle valve	iv. Set it correctly,

IV. Lean Mixture in High Speed :

Causes	Remedies
i. Less Fuel Pump pressure	i. Leaking out-let valve of fuel pump correct it.
ii. Obstruction in fuel line	ii. Clean it
iii. Float level setting too low	iii. Set correct level
iv. Wrong size of metering rod or jet	iv. Use correct size.
v. Mis adjustment of throttle opening & metering rod.	v. Adjust correctly
vi. Obstruction in passage of metering jet sleeve	vi. Clean it
vii. Worn out throttle or its shaft.	vii. Change it

V. Rich Fuel in High Speed Circuit.

i. High Fuel Pump Pressure.	i. Use thicker gasket between pump body & block.
ii. High setting of float level.	ii. Set correct level
iii. Clogged metering rod spring or spring come out of its position.	iii. Replace spring of fix it right.

iv. Worn out metering rod and main jet or bent metering rod	iv. Replace or repair bending.
v. Sticky choke valve	v. Lubricate choke valve linkages.
vi. Choked air cleaner	vi. Clean it
vii. Obstruction in passage of air bleed hole to main jet	vii. Clean the passage
viii. Cracked or torn out	viii. Replace it.

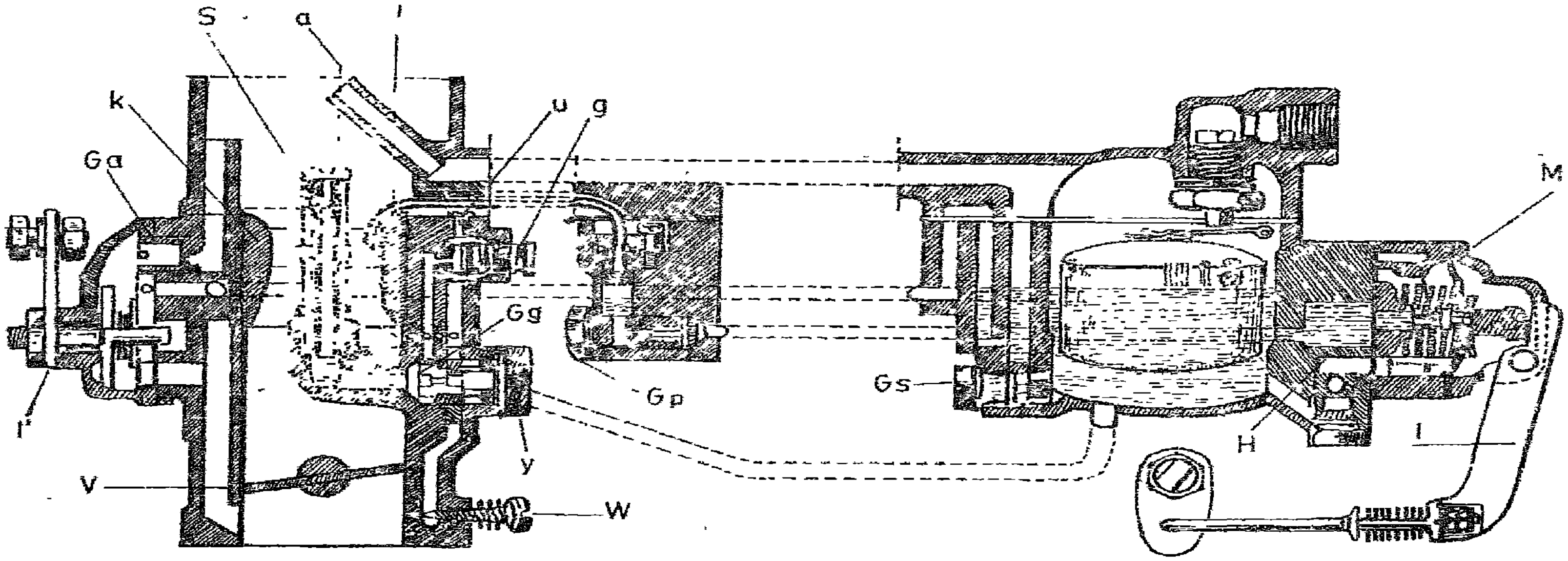
VI. Accelerator Pump Sending Lean Mixture

Causes	Remedies
i. Weak plunger spring.	i. Replace it
ii. Worn out plunger cap washer	ii. Replace it
iii. Leaky feed pump valve	iii. Replace it
iv. Obstruction in fuel feed-line	iv. Clean it
v. Blocked acceleration jet	v. Clean it
vi. Feed pump stroke defective	vi. Check up for worn out rocket or working of diaphragm.

VII. Accelerator Pump Sending too Rich Mixture :

i. Bigger stroke of accelerator	i. Set stroke
ii. Bigger hole of accelerator jet	ii. Replace jet.

FIG-5.1.1 CARBURETTOR DIAGRAM



a - AIR CORRECTION JET
Gg - MAIN JET
Gp - PUMP JET
Gs - STARTER PETROL JET
Ga - STARTER AIR JET
g - PILOT JET

H - PUMP VALVE
I - PUMP INJECTOR
k - CHOKE TUBE
I - PUMP LEVER
I' - STARTER AIR JET
M - PUMP MEMBRANE

S - EMULSION TUBE
u - PILOT AIR BLEED
v - THROTTLE
w - VOLUME CONTROL SCREW
y - MAIN JET CARRIER

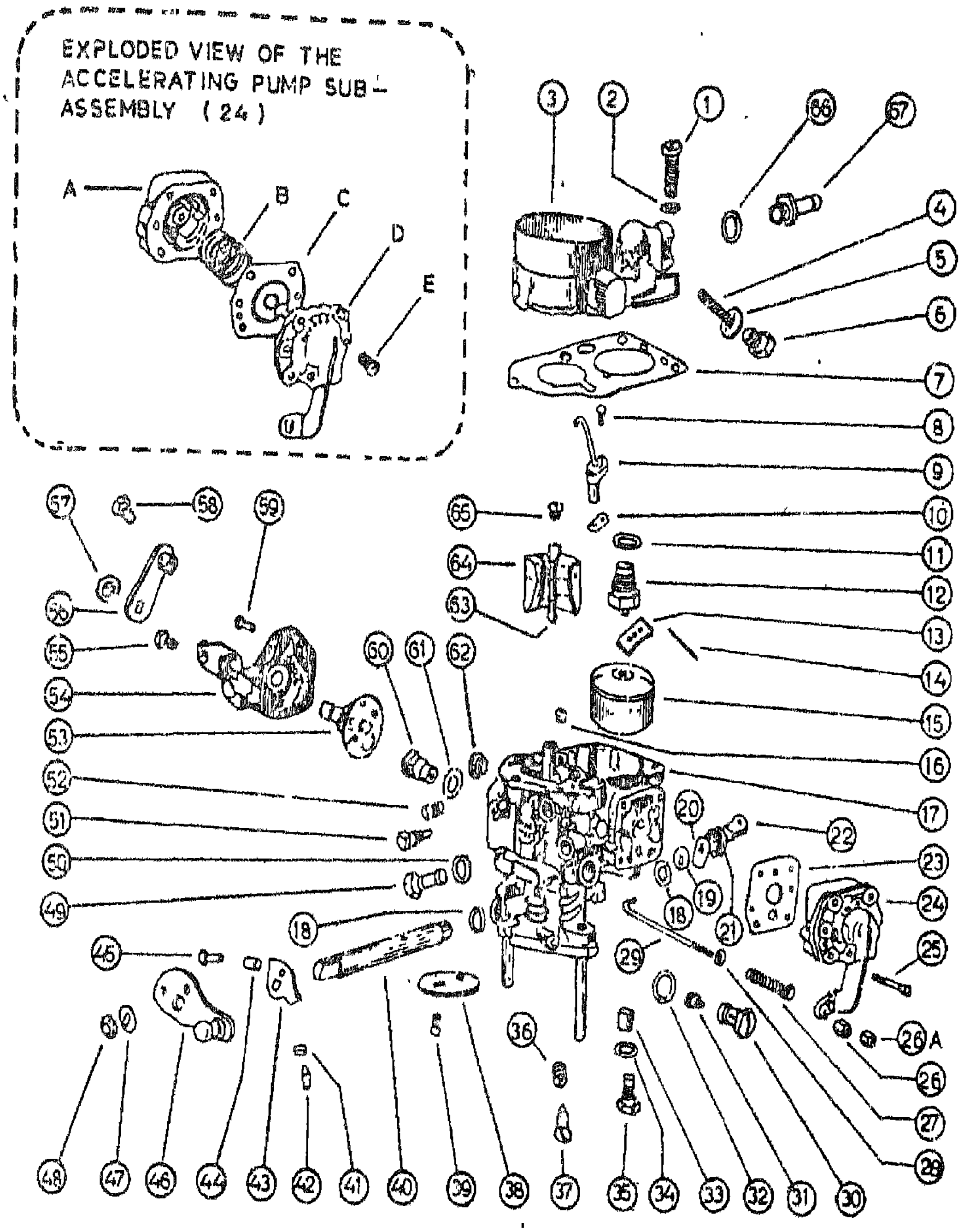
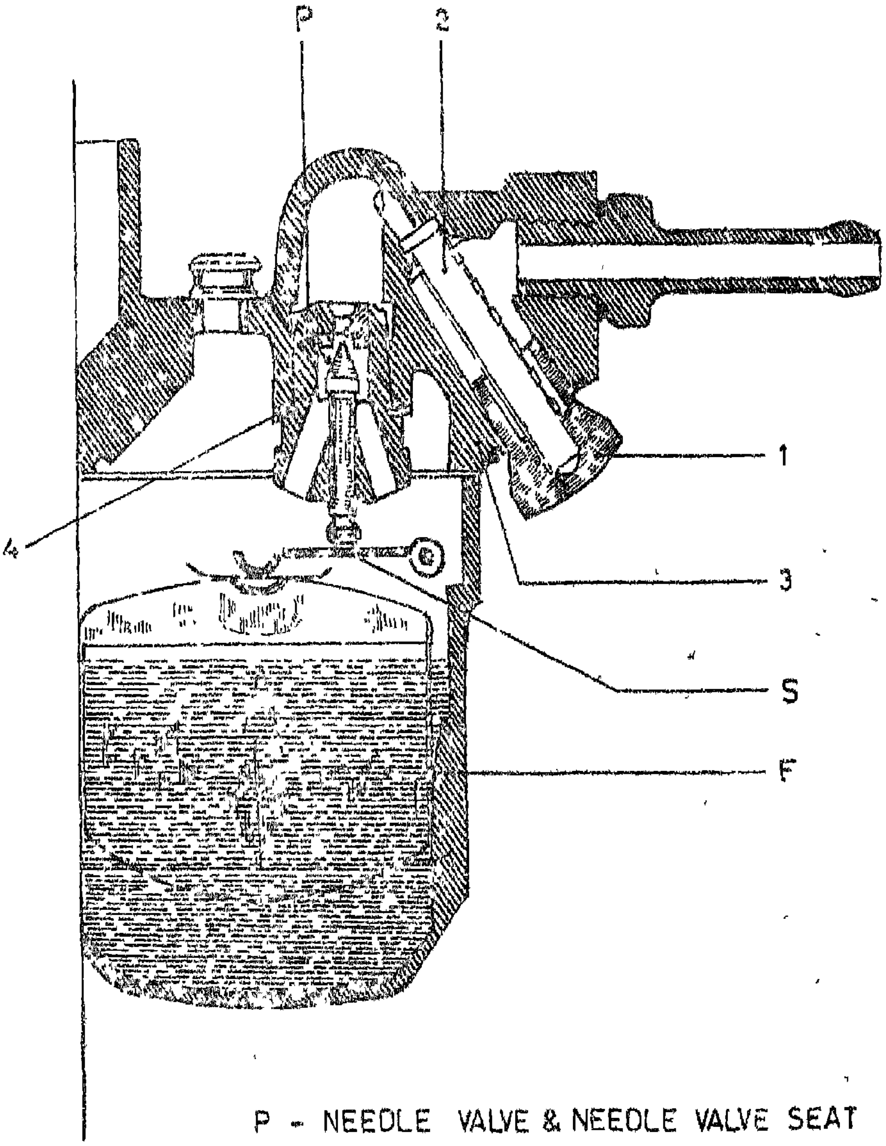


FIG. 5·1·2 – CARBURETTOR EXPLODED VIEW

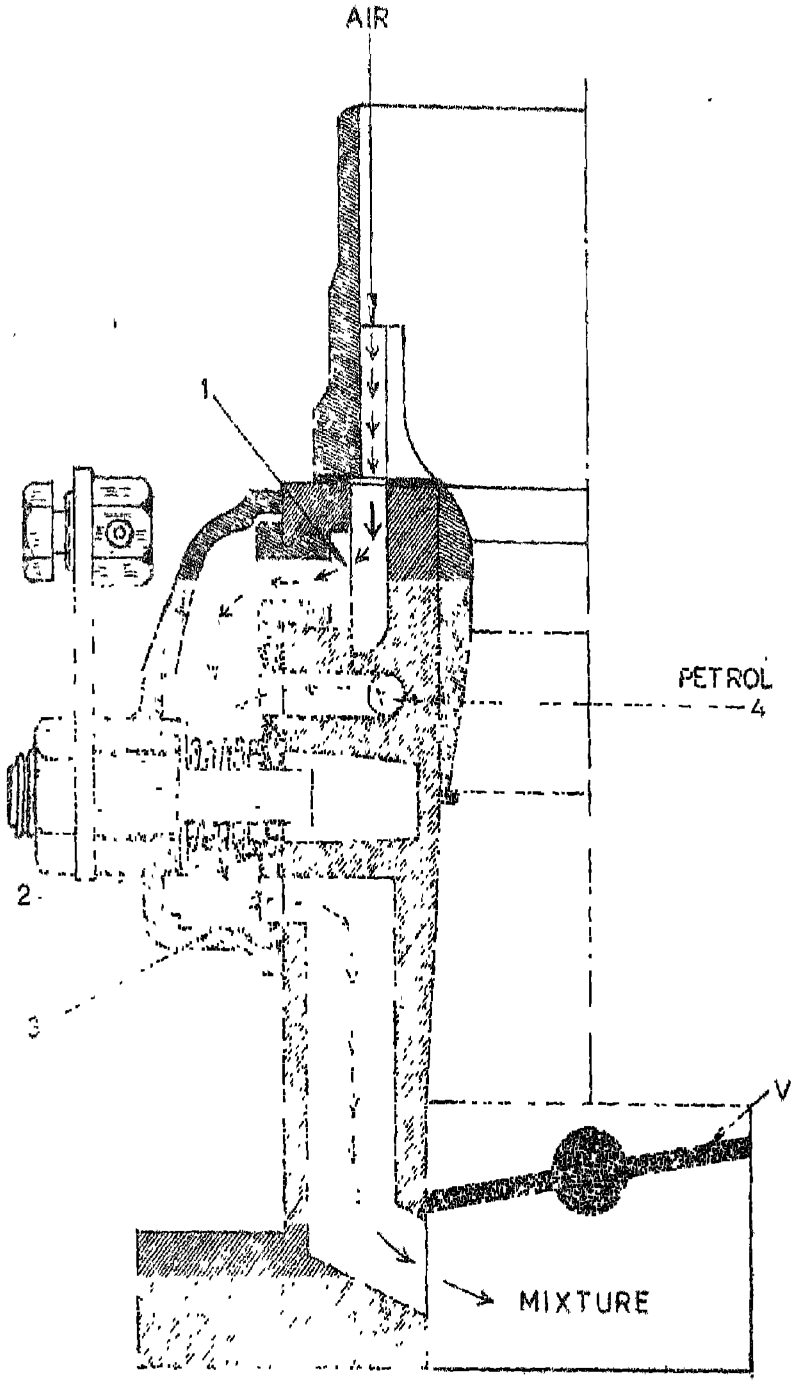
FIG-5.13

CARBURETTOR FLOAT SYSTEM



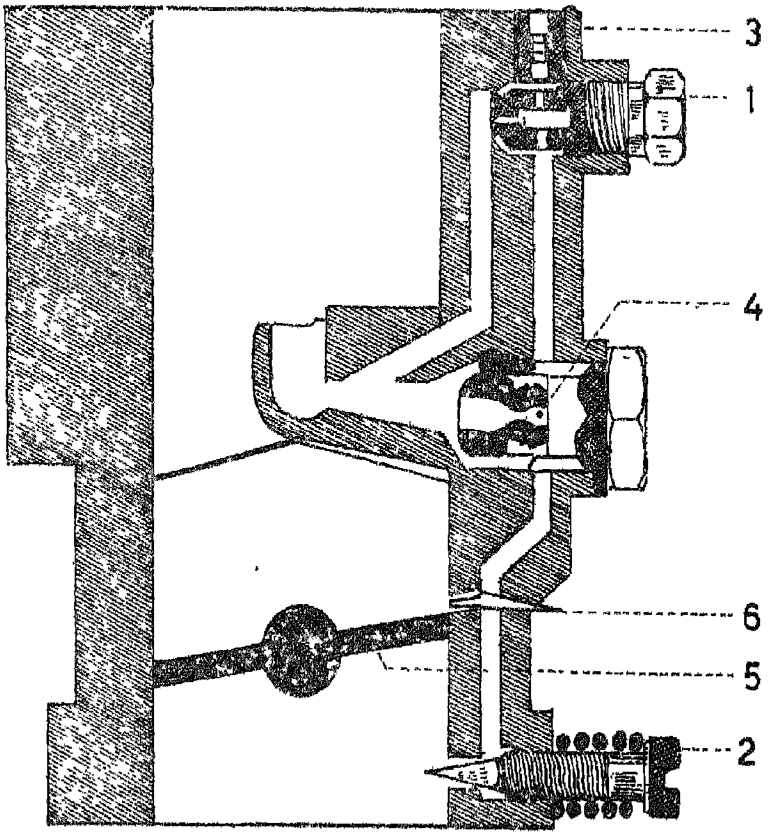
P - NEEDLE VALVE & NEEDLE VALVE SEAT
F - FLOAT
1 - FILTER COVER NUT
2 - FILTER
3 - GASKET

FIG.-5.1.4-STARTER SYSTEM OF CARBURETOR



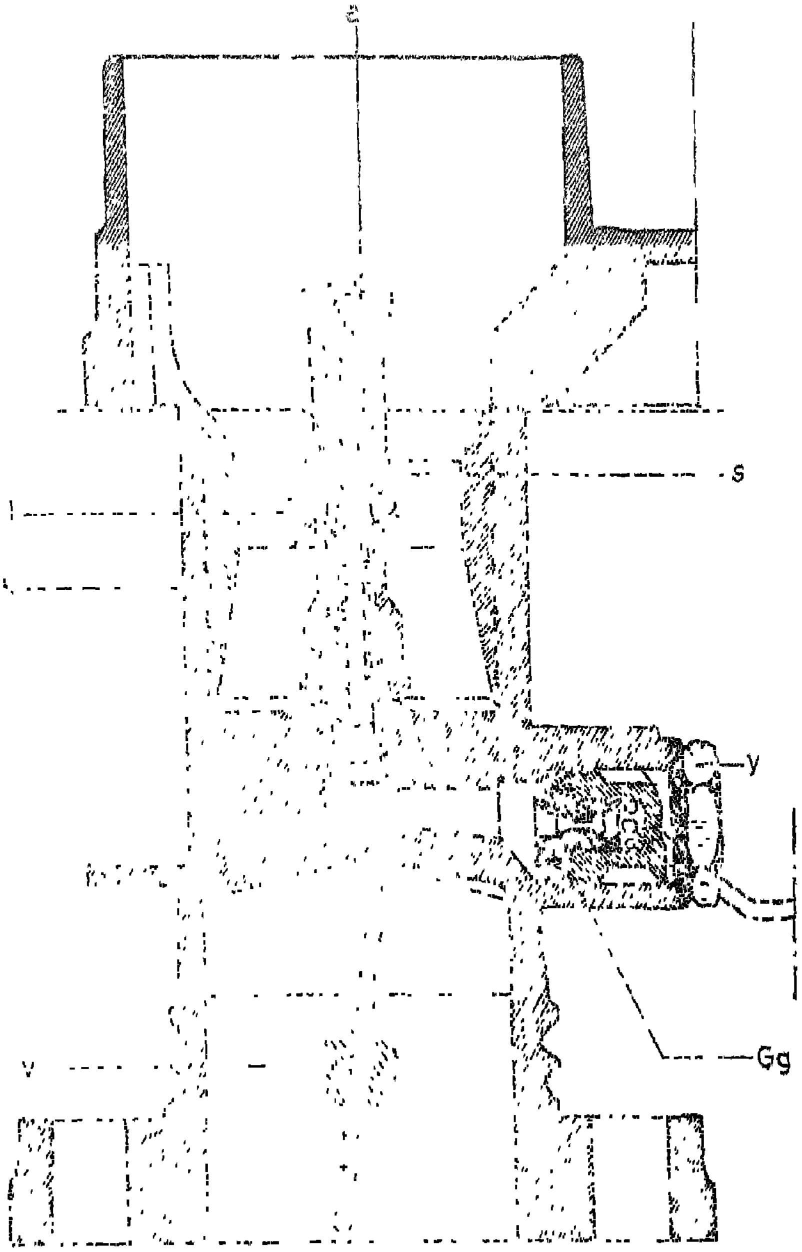
1 STARTER AIR JET
2 STARTER DISC VALVE
3 MIXTURE PASSAGE
4 PETROL SUPPLY.

FIG. 5.1.5
SLOW SPEED JET SYSTEM OF CARBURETTOR



1 PILOT JET
2 VOLUME CONTROL SCREW
3 PILOT AIR BLEED
4 MAIN JET
5. THROTTLE BUTTERFLY

FIG 5.1.6 MAIN SPRAYING SYSTEM OF CARBURETTOR



Gg - MAIN JET

y - MAIN JET CARRIER

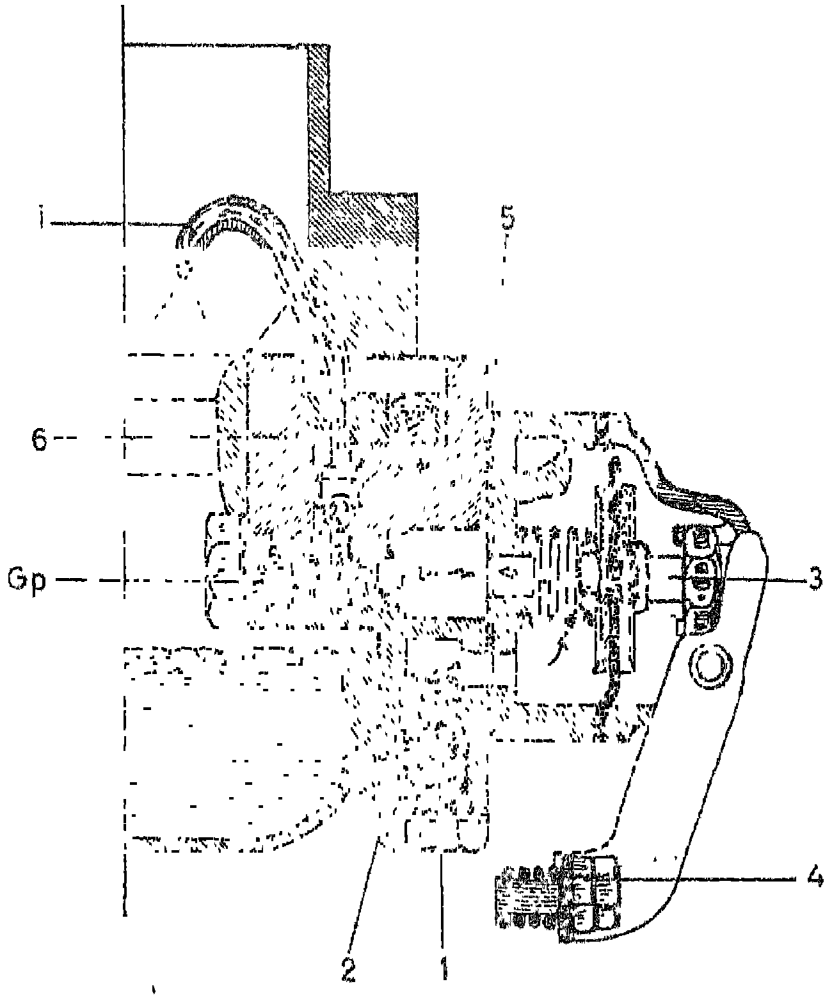
l - SPRAY NOZZLE

k - VENTURI

v - THROTTLE BUTTRFLY

s - EMULSION TUBE

FIG. 5·1·7 ACCELERATING PUMP SYSTEM OF CARBURETTOR



Gp - PUMP JET
i - PUMP JET TUBE
1 - PUMP INJECTOR
2 - NON RETURN VALVE
3 - DIAPHRAGM ASSEMBLY
4. - PUMP CONTROL ROD WITH NUT.

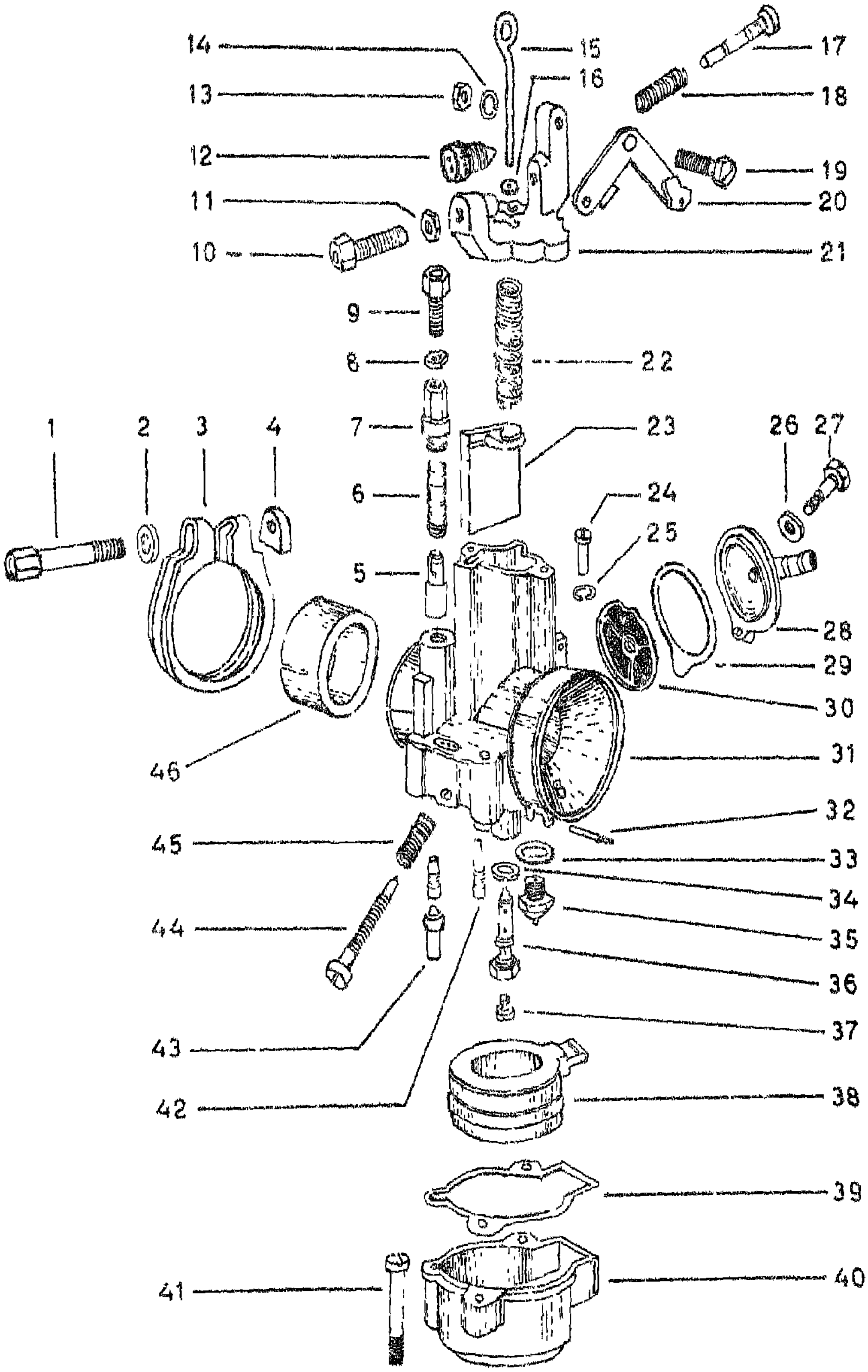
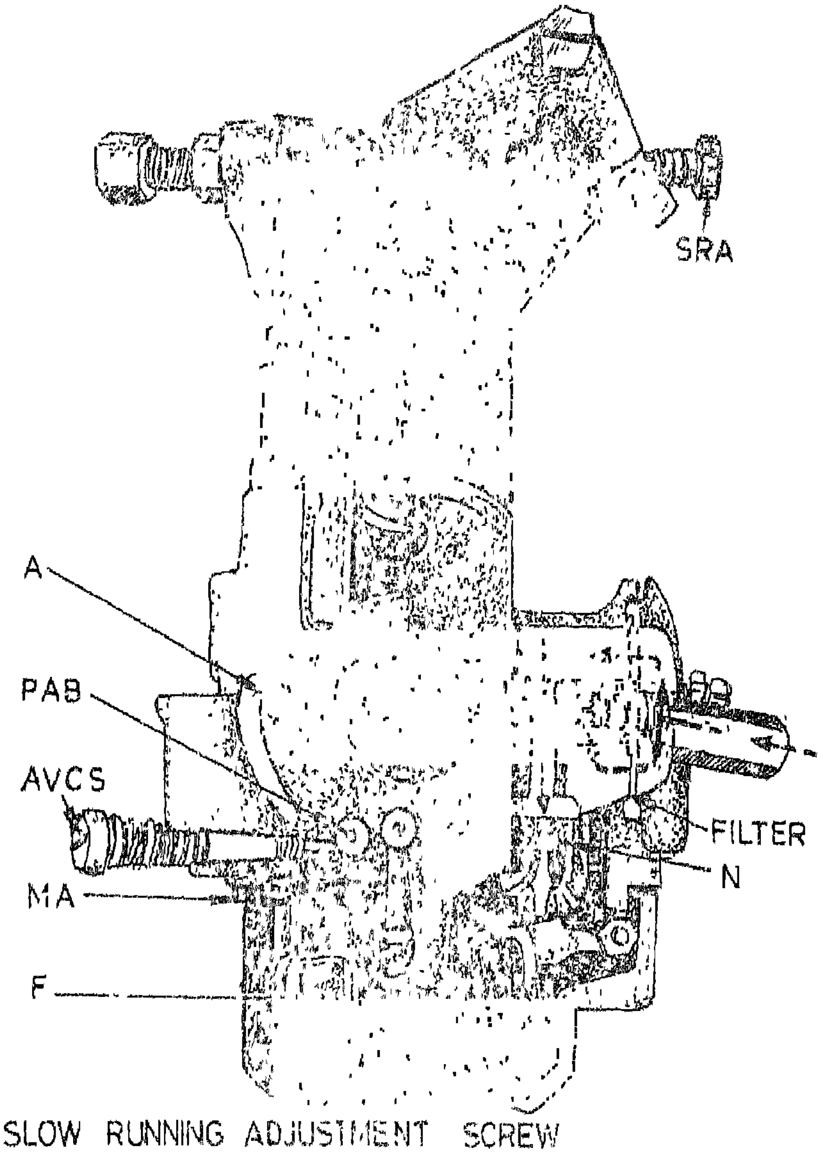


FIG-5.1.8 EXPLODED VIEW

PART LIST

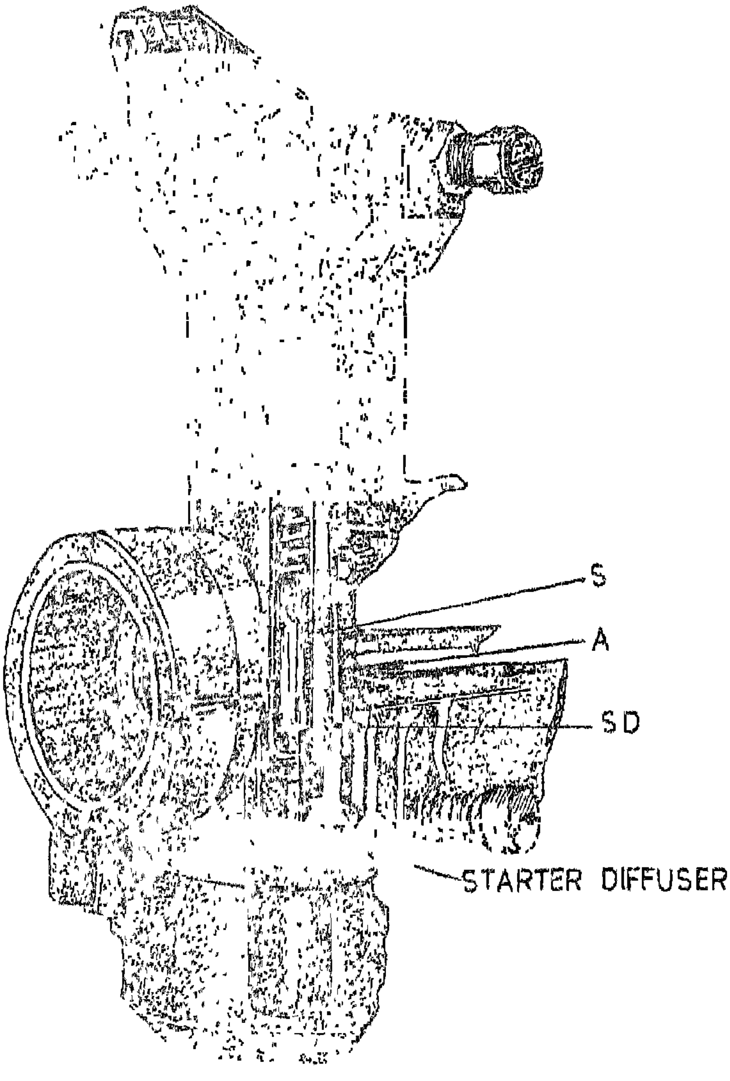
IT. NO.	DESCRIPTION	NO. OFF	IT. NO.	DESCRIPTION	NO OF
1	CLAMPING BOLT	1	24	CAP FIXING SCREW	2
2	CLAMP WASHER	1	25	SPRING WASHER	2
3	CLAMP	1	26	FIBRE WASHER	1
4	CLAMPING NUT	1	27	INLET COVER FIXING SCREW	1
5	STARTER SLIDE	1	28	FUEL INLET COVER	1
6	STARTER SPRING	1	29	GASKET	1
7	STARTER ADAPTOR	1	30	FILTER	1
8	LOCK NUT	1	31	MAIN BODY	1
9	STARTER CABLE GUIDE	1	32	FLOAT TOGGLE SPINDLE	1
10	THROTTLE CABLE GUIDE	1	33	WASHER	1
11	LOCK NUT	1	34	WASHER	1
12	DUST CAP	1	35	NEEDLE VALVE	1
13	LEVER LOCKING NUT	1	36	MAIN DIFFUSER	1
14	SPRING WASHER	1	37	MAIN JET	1
15	THROTTLE HOOK	1	38	FLOAT	1
16	DUST WASHER	1	39	FLOAT BOWL GASKET	1
17	SLOW RUNNING ADJUSTMENT SCREW	1	40	FLOAT BOWL	1
18	SLOW RUNNING ADJUSTMENT SPRING	1	41	FIXING SCREW	2
19	LEVER FIXING SCREW	1	42	PILOT JET	1
20	ACCELERATOR LEVER	1	43	STARTER DIFFUSER	1
21	CAP	1	44	AIR VOLUME CONTROL SCREW	1
22	THROTTLE SLIDE SPRING	1	45	VOLUME CONTROL SCREW SPRING	1

FIG-5.1.9 SECTIONED VIEW OF CARBURETTOR SHOWING FLOAT SYSTEM



SRA - SLOW RUNNING ADJUSTMENT SCREW
N - NEEDLE VALVE
AVCS - AIR VALUME CONTROL SCREW
MA - MAIN AIR BLEED
A - AIR CIRCUIT
PAB - PILOT AIR BLEED
F - FLOAT

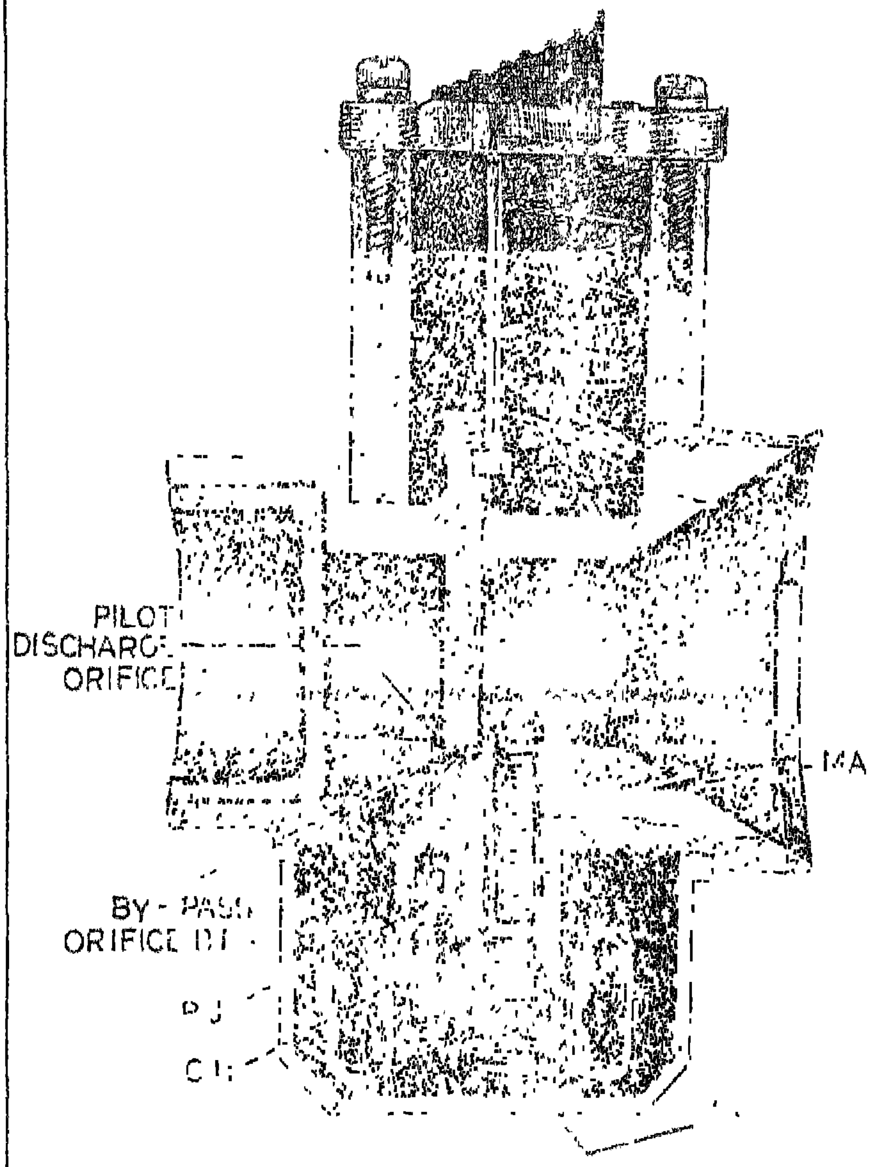
FIG. 5.1.10
SECTIONED VIEW OF CARBURETTOR SHOWING STARTER SYSTEM



S STARTER SLIDE
SD - AIR CIRCUIT
A - AIR CIRCUIT

FIG.- 5·1·11 -

SECTIONED VIEW OF CARBURETTOR SHOWING SLOW SPEED SYSTEM



PJ - POINT JET

MJ - MAIN JET

CH - CROSS HOLE

MA - MAIN AIR BLEED

MA - MAIN AIR BLEED
PAB - PILOT AIR BLEED
DH - MAIN DIFFUSER-DISCHARGE HOLE
MJ - MAIN JET
PJ - PILOT JET
AVCS - AIR VOLUME CONTROL SCREW
AV - AIR PASSAGE

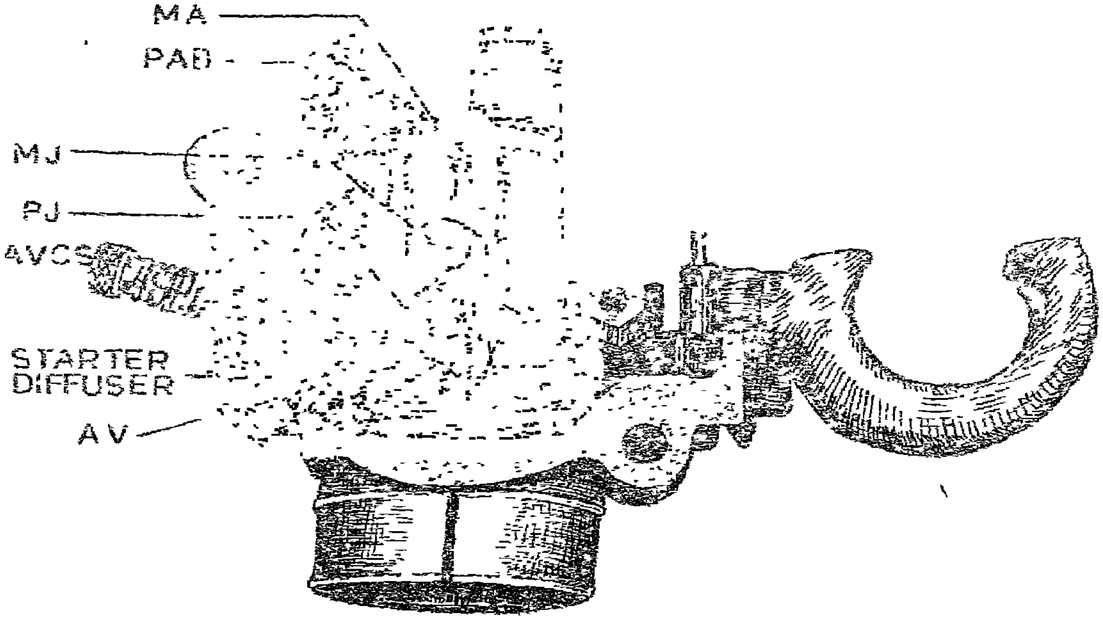
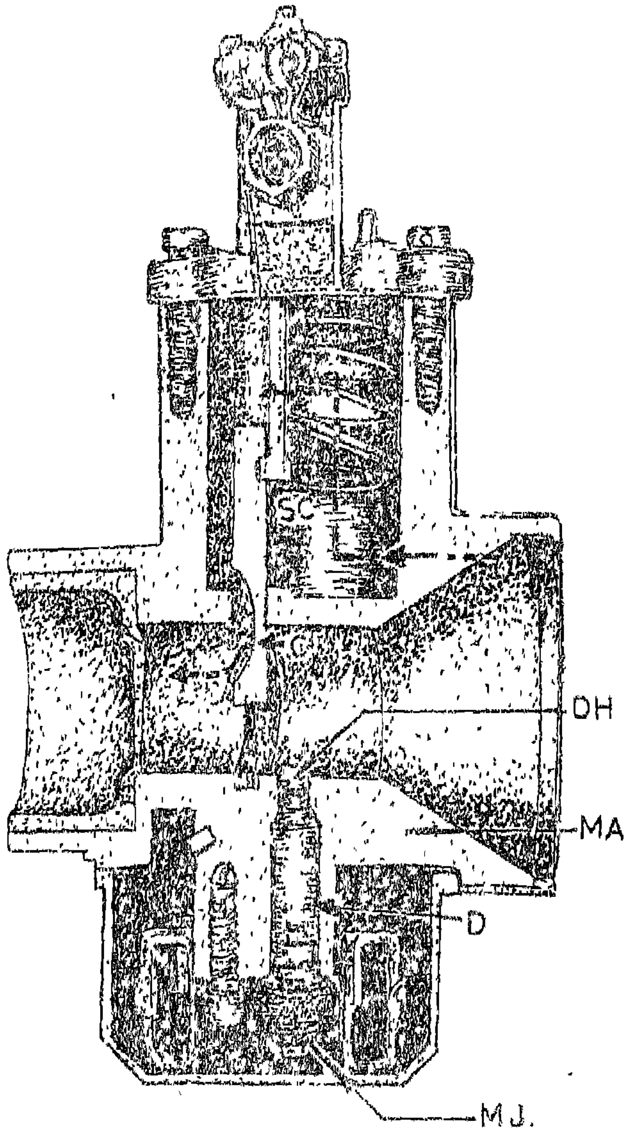


FIG NO - 5.1.12 SECTIONED VIEW OF CARBURETTOR SHOWING SLOW SPEED SYSTEM.

FIG NO - 5.1.13 SECTIONED VIEW OF CARBURETTOR SHOWING MAIN JET SYSTEM



DH-MAIN DIFFURGE HOLE
MA-MAIN AIR BLEED
D-MAIN DIFFUSER
MJ MAIN JET

EVALUATION QUESTIONS

1. What is the purpose of the Carburettor ?

2. Is it permissible to use a pin or a piece of wire to clear a jet?

3. How can a punctured float be detected?

4. What items require lubrication in connection with the Carburettor?

5. What is the method of adjusting the slow running speed?

6. What is the effect of leaking induction joint?

7. How can a defective joint be located?

8. It is a cold engine refuses to start, the ignition being in order, what is the procedure for starting?

9. What is the probable cause of a warm engine failing to start, assuming the ignition is correct?

10. The engine starts up satisfactorily but refuses to run slowly, even when warm, state the cause and remedy?

11. If an engine runs satisfactorily at slow and medium speeds, but refuses to accelerate, what is the probable cause, assuming the ignition is in order?

12. How can the petrol consumption be reduced?

13. What is flat spot?

/TARA/

Experiment No. 6.1

General Objective : Study of various types of clutches.

Specific Objectives :

1. To know the constructional features of clutches used on Scooters, Motor Cycles, and Cars.
2. To dis-assemble, inspect, repair and re-assemble the above mentioned clutches.
3. To know the trouble shooting.

Introduction

1. With the vehicle stationary on the road, it requires a good amount of tractive effort to start. The engine at very low speed does not develop torque sufficient enough to make the vehicle move on the road.
2. For functioning of the gear box, it is required that each time a shift is necessary it should be detached from the flow of power from the engine. To look after the above mentioned functions, a device, called clutch, is incorporated between the engine flywheel and the gear box. It is a variable friction coupling between the driving and the driven members.

Equipment

1. Scooter clutch
2. Motor Cycle clutch
3. Moped clutch
4. Car clutch

Tools

1. Open-ended Spanner Set
2. Ring-Spanner Set
3. Screw Driver
4. Mechanical or Hydraulic Jack
5. Lock pliers
6. File
7. Plastic mallet
8. Torque Wrench
9. Clutch Centring Mandrel
10. Punch

Constructional features of the clutch used on a Scooter

The figure 6.1.1 gives the exploded view of a clutch used on a scooter (Bajaj)

The various components are very well depicted in the figure.

Dis-assembly of the clutch used in a scooter.

1. Park the vehicle at proper place
2. Drain out the gear box oil.

3. Open the clutch cover
4. Remove the locking nut or pins by using puller.
5. Open the locks or nuts.
6. Take out clutch plates and pressure plates.
7. Wash and clean all the parts with a cleaning solvent.

Inspection & Repairs

1. Inspect clutch plates for wear
2. Inspect pressure plates for cracks
3. If the clutch plates are worn out, replace them with new plates. If cracks are observed in pressure plates replace them with new pressure plates.
4. Inspect clutch springs for free-length and tension. If weak, replace them.
5. Inspect all nuts for threads. If spoiled, replace.
6. Replace circlip if weak or broken

Assembly

Assemble all the parts in the reverse order of dis-assembly. Fill up the oil to the required level.

Clutch for Four-Wheelers

The Clutch used on Cars is a dry type disc clutch, having a friction plate provided with friction materials on both sides. The constructional features of this type of clutch are clearly depicted in figure 6.2.2.

Dis-assembly

1. For Ambassador car first remove engine from the chassis and necessary foundation bolts are opened. For fiat car we disconnect the drive lines from gear box side. Take out cross member and gear box foundation. Disconnect clutch lever and bell housing bolt. Disconnect the speedometer cable also.
2. Take out gear box.
3. Open the pressure plate by removing the round bolts from the flywheel.
4. Fit the pressure plate in the Arbor Press and loosen the finger adjusting nuts.
5. Dismantle eye bolts, springs, pressure plate clutch release lever and release lever spring.
6. Wash the clutch disc in petrol and other parts in kerosene oil.
7. Inspect all the parts for the wear.

Inspection & Repairs

1. Check the flywheel surface. If the flywheel surface has hard spots, then take out the flywheel from the engine and grind the surface. Take care of the position of the flywheel while dismantling otherwise the balancing may be disturbed. Replace the flywheel ring gear if it is damaged or worn out.

2. Check the position of the rivets. If the wear of the clutch facing is more, then the facing should be replaced, or replace the clutch plate if necessary.

3. Check the surface of the pressure plate. If it has hard spots on lining, then grind the surface, or replace the whole pressure plate assembly if necessary.

4. Check the spings and replace the damaged or broken or worn out parts.

Assembly :

1. Lubricate eyebolt pin.
2. Fit fingers with strut and eye bolts on the pressure plate.
3. Put the spings in their original position on the pressure plate.
4. Fit Anti-Rattle spring (finger- return spring) on the clutch cover.
5. Fit pressure plate in the Arbor press (clutch fixture) and apply pressure on the fingers and tighten the eyebolt nuts (finger adjusting nuts). Move the bar of the Arbor press up and down to see the movement of the release fingers. There should not be any sticking and movement should be free.

7. Adjust the height of the fingers according to the recommendations of the manufacturer. Note that the height of all the fingers must be the same.
8. Lock the eye-bolt nuts and remove the pressure plate assembly from the Arbor press.
9. Check the release bearing or clutch carbon for its wear and replace if necessary.
10. Fit the flywheel with the engine in the proper position taking care of the balancing mark etc.
11. Tighten the flywheel bolts or nuts by the torque wrench according to the recommendation of the manufacturer.
12. Lock the bolts or nuts of the flywheel.
13. Lubricate the pilot bush or bearing.
14. Fit the clutch assembly with the help of clutch centring tool to the flywheel. Take care that the flywheel side of the clutch plate should be at the flywheel side.
15. Fit the gearbox to the vehicle and tighten the bell housing bolts.
16. Check the gear box foundation. Replace it, if necessary.
17. Check the clutch pedal free play & make the necessary adjustment so that free play is between 13 mm to 37 mm (½ in to 1½ in)

18. See that there is no free play in [illegible] linkage-bushes. Replace the worn [illegible].

19. Connect the drive lines with the [illegible].

Trouble Shooting

Trouble	Causes	Remedy
1. Clutch slipping	(a) No free play in the pedal	Adjust pedal free play
	(b) Weak pressure springs	Replace them.
	(c) Worn out clutch plate	Replace it.
	(d) Oil, grease etc. on clutch facings	Replace soaked plate
	(e) Excessively worn out flywheel surface	True it.
2. Clutch dragging or spinning	(a) Clutch shaft out of line with engine shaft	(i) Replace worn out pilot bearing in crank shaft tail (ii) Tighten loose holdin down-bolts of gearbo
	(b) Warped or damaged pressure plate	Replace
	(c) Clutch plate hub binding on splines	Replace
	(d) Clutch plate distorted	Replace
	(e) Cushion springs damaged	Replace clutch plate
	(f) Oil grease etc. on clutch plate.	Clean or replace the plate
3. Clutch judder	(a) Linings not making proper contact	(i) Replace clutch plate (ii) Replace flywheel and pressure plate
	(b) Pressure plate not parallel with flywheel	(i) Tighten loose bolts holding pressure plate with cover. (ii) Replace distorted pressure plate cover.
	(c) Buckled clutch plate	Replace
	(d) Bent clutch shaft	Replace

4. Clutch rattling	(a) Worn release bearing	Replace
	(b) Worn release bearing carrier	Replace
	(c) Worn release fork	Replace
	(d) Disconnected pedal return spring.	Connect it
	(e) Release fork loose on ball stud.	Replace ball stud.
5. Clutch squeaks	(a) Clutch release bearing improperly lubricated	Lubricate it
	(b) Pilot bearing ill lubricated	Lubricate it
	(c) Release sleeve ill lubricated	Lubricate it
	(d) Misalignment	Make proper alignment
6. Clutch vibrates	(a) Bent clutch shaft	Replace it
	(b) Defective clutch disc	Replace it
	(c) Dust in clutch	Clean or wash it
	(d) Use of rigid disc in-stead of flexible type	Use the flexible disc
	(e) Unmatched springs	Use a matched set of springs or replace it
	(f) Misalignment	Make proper alignment
7. Complete failure of clutch	(a) Disc hub worn out	Replace it
	(b) Friction disc torn off or worn out	Replace it
	(c) Broken springs	Replace them
	(d) Incorrect adjustment of pressure plate	Adjust it in proper way.
	(e) Improper adjustment of clutch or pedal	Adjust it properly
	(f) Splined hub stuck on splined shaft.	Make it free or replace it.

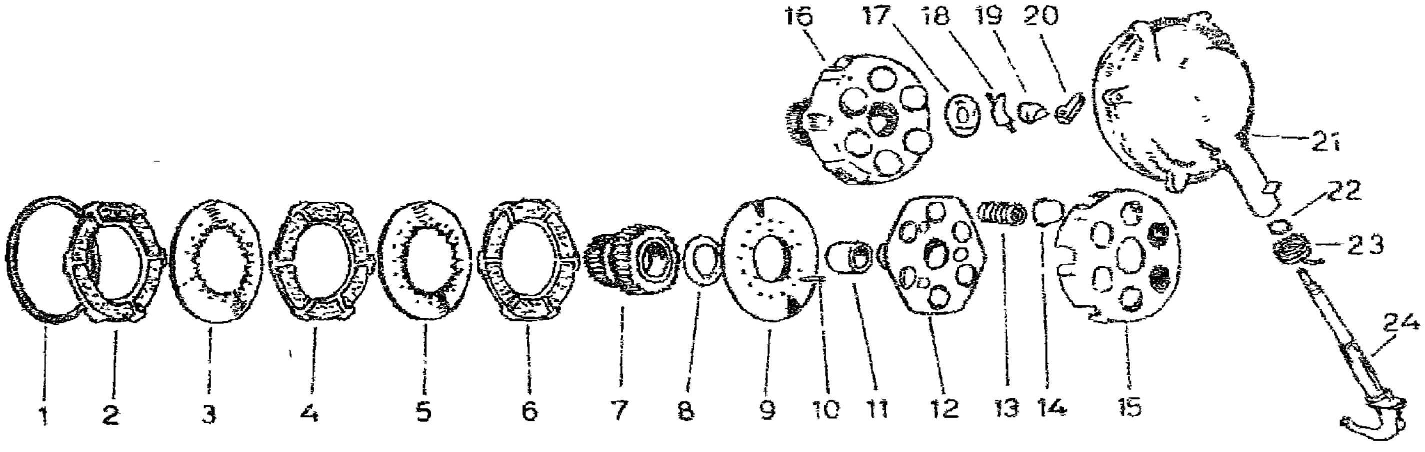


FIG NO - 6.1.1 CLUTCH ASSEMBLY

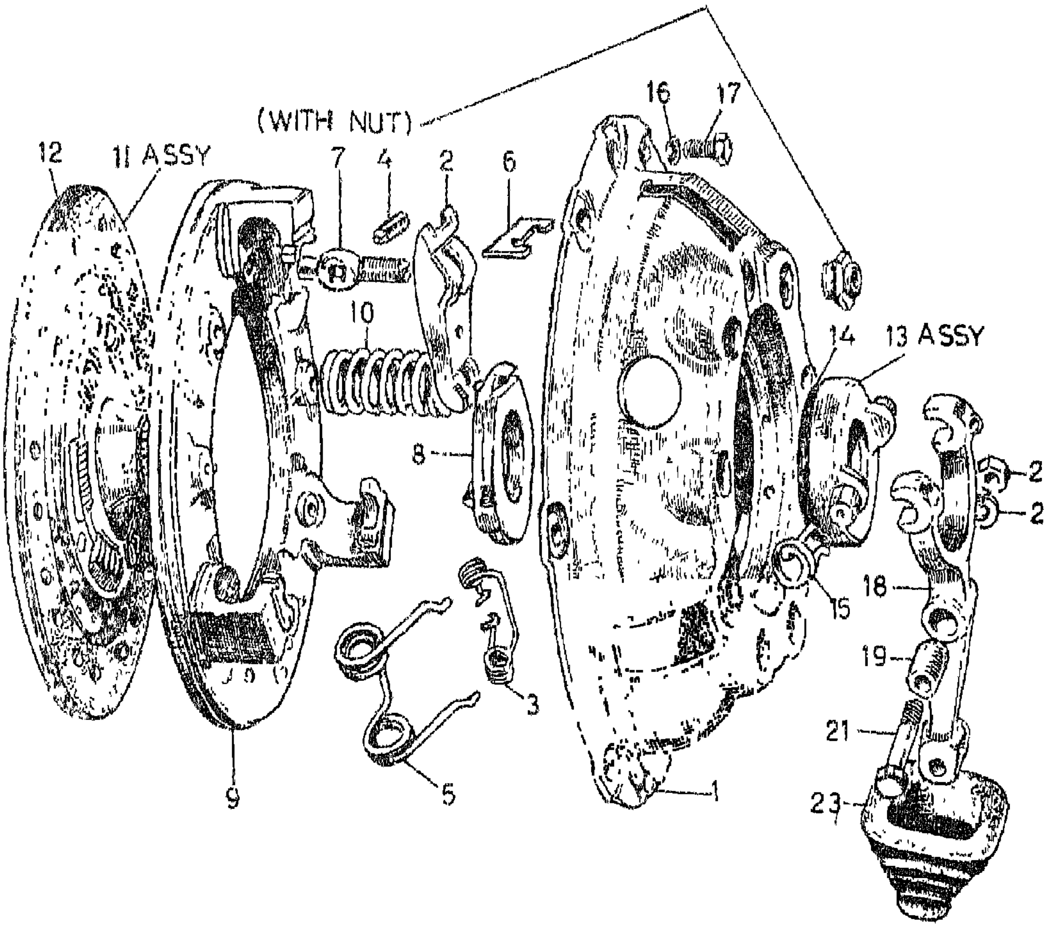
Legend of Fig. 6.1.1.

CLUTCH ASSEMBLY

1. Locking ring.
2. Driven Plate
3. Drive plate
4. Driven Plate
5. Plate
6. Driven Plate

7, 8, 9 & 10 Hub assembly.

11. Bush
12. Plate with bush.
13. Spring 6 Nos. (only one shown)
14. Cup for spring (only one shown).
15. Clutch case.
16. Clutch assembly (with all parts from 1-15)
17. Pressure plate.
18. Spring clip.
19. Plunger
20. Lever.
21. Clutch cover.
22. Washer.
23. Spring.
24. Clutch lever external.



FIGNO-6.1.2 THE CLUTCH COMPONENTS

Legend of Fig. 6.1.2

Key to Clutch components.

1. Cover - Clutch.
2. Lever - Release.
3. Retainer - lever.
4. Pin Lever.
5. Spring -Anti-rattle.
6. Strut.
7. Eyebolt with nut.
8. Plate - bearing thrust.
9. Plate - pressure.
10. Spring - Pressure plate.
11. Plate assembly - driven.
12. Lining
13. Ring assembly - thrust.
14. Ring - Carbon.
15. Retainer.
16. Washer - spring cover screw.
17. Screw - Cover to flywheel.
18. Lever assembly withdrawal.
19. Bush.
20. Washer spring Lever bolt.
21. Bolt-Lever.
22. Nut-bolt.
23. Cover-dust.

Trouble Shooting for Scooter

Trouble	Causes	Remedies
1. Clutch slipping	1) No free play in clutch plates	1) Adjust or replace clut plate or springs
	2) Excess free play	2) Replace clutch plates.
	3) Weak springs	3) Replace
	4) Worn out splines of	4) Replace
	5) Sticking clutch cable.	5) Replace cable.

Questions

1. What is the object of the clutch?
2. What item should first be checked when clutch slip occurs?
3. What is the effect if there is no free movement of the pedal and lever?
4. Does a clutch require any lubrication?
5. What is meant by a dry and wet clutch?
6. What is the difference between single plate and multiple plate clutch?
7. How will you find out whether a clutch has failed?
8. How will you distinguish between driving member and driven member?
9. If the pressure springs are weak what will happen to the vehicle and give reasons?

/TARA/

Experiment No. 2

1. **General Objective :** Study of a clutch used on a Moped.

2. **Specific Objectives:**

   1. To know the construction of a centrifugal clutch used on Mopeds.
   2. To know the working of the above clutch.
   3. To dis-assemble, inspect, repair and reassemble the above clutch.

3. **Introduction**

It is an automatic clutch which is controlled by the engine speed through the accelerator. When the engine speed falls down, the clutch is automatically disengaged and when the speed rises above the predetermined value, the clutch is engaged. Greater the centrifugal force due to higher engine speed, more powerful the contact between the driving and driven members and better the engagement.

4. **Tools and Equipment**

   1. Screw Driver
   2. Clutch puller
   3. Set of Ring Spanners
   4. Set of open-end spanners
   5. Friction linings
   6. Springs
   7. Circlips etc.

Construction and working

The simplest form of centrifugal clutch consists of two members, one fitted on the driving shaft and the other attached to driven shaft. The driven member is just a drum which encloses the driving member. The driving member contains two curved shoes having frictional linings at their backs. The shoes are anchored at one end to the back plate and are kept in position by means of coil springs which hold the free end.

The driving member rotates with the engine shaft. As the engine speed increases, the shoes inside the driving member drum fly outwards due to centrifugal force and come into contact with the inner surface of the driving drum. The increasing centrifugal force due to higher engine speed, binds the driving member with the driven member resulting in the movement of both the members and shafts at the same speed.

As the engine speed decreases, the centrifugal force due to which the driving and driven members are connected with each other, also decreases which results in disengagement.

(b) Moped vehicle

Dis-assembly

(1) Lock the engine and then take out clutch [illegible].

(2) With the help of screw driver, take out the clutch assembly from crank shaft and also [illegible] bush.

(3) Dismantle all the parts.

(4) Remove speed liners from their pins (mounting pins)

(5) Take out starting liners removing the circlips. While removing, take care that the springs do not fly away.

(6) Separate out speed liners.

(7) While separating speed liners take care that the balls should not fly away.

Inspection and Repairs

(1) Check spring tension of speed liners. If found improper replace the entire set of the springs.

(2) Check roughness of speed liners, if they are smooth, file it for roughness. If wear is too much, replace it.

(3) Check starting liners also for roughness.

(4) Check clutch bell for roughness.

Assembly

(1) Assemble starting liners in proper way if they are fitted in reverse way, the clutch will not work. Check that damping springs are fitted

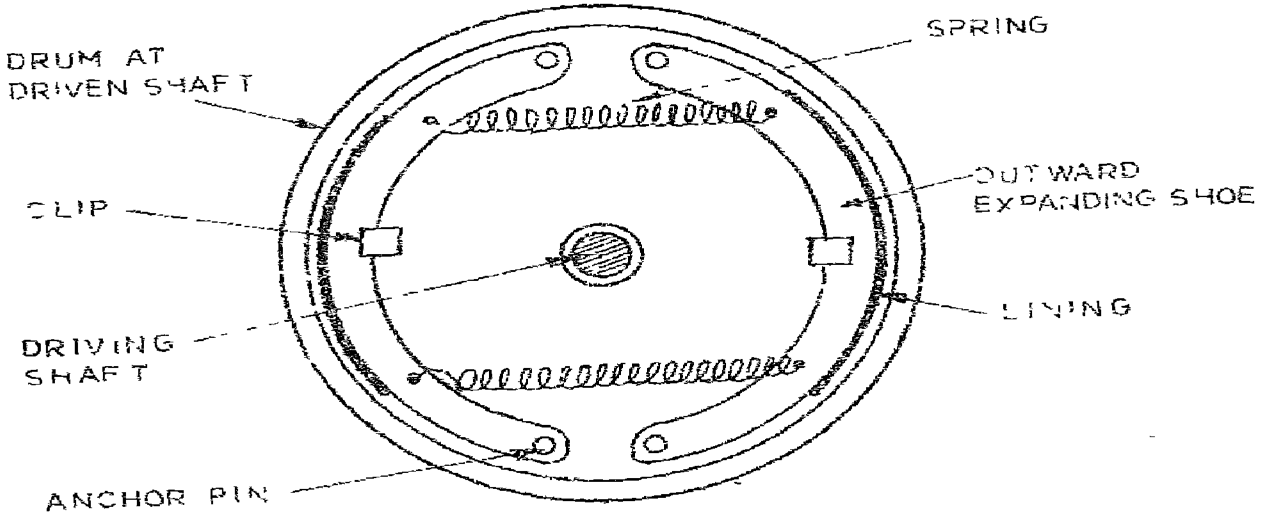


FIG NO-6.2.1 CENTRIFUGAL CLUTCH

properly. Fit circlips on starting liners.

(2) Fix centre plate along with speed liners which are mounted on the pins. While fitting centre plate, keep in mind that the rib of crank shaft and centre plate rib should match each other. Make sure that the starting liners are aligned with the centre plate inner portion. This will be done by rotating the centre plate forward and reverse.

(3) Make sure that bush is lubricated with the grease and then mounted on crank shaft. See that the grease is applied on the inside surface and not on outside surface.

(4) Keep outer plate on speed liners, and lock the engine and tighten the clutch nut.

(5) Take care that V-belt is in the bell groove while assembling the clutch on crank shaft other wise belt will not mount in the V-groove.

Evaluation Questions

1. What is meant by centrifugal clutch?
2. Distinguish between starting liners and speed liners of the centrifugal clutch?
3. If the speed liners in centrifugal clutch are fitted in a reverse way what will happen with the vehicle?

/TARA/

Experiment No. 7.1

1. General Objective : Study of Gear Box

2. Specific Objectives :

   1. To know construction and working of Gear Box and Transfer case of four wheelers.
   2. To dismantle inspect, repair, test and assemble Gear Box of four wheelers.
   3. To know construction and working of Gear box of two wheelers (Scooters and Motor Cycle)
   4. To trouble shoot, dismantle, inspect, repair, test and assemble Gear Box of two wheelers.
   5. To determine speed ratios by engaging various gears.

3. Introduction :

By selecting the correct gear in the gearbox, the engine can operate without strain, and drive the vehicle under any conditon of road, speed and load. Depending on the situation, a proper speed ratio can be selected in the gear box. When a vehicle is started from rest it needs more torque at the wheels and maximum speed ratio is selected in the gear box. Depending on the gear changing mechanism, the gear box is of three types:

1. The sliding mesh gear box.
2. The constant mesh gear box.
3. The synchromesh gear box.

Generally the cars are two wheel - drive. Four wheel drive vehicles, have combination of auxiliary gear box with main gear box. The auxiliary gear box is also known as transfer case. Part of the power is transferred to rear wheels and remaining to front wheels. With four wheel drive, vehicle becomes more versatile. If the two rear wheels are on slippery surface, the front two wheels can move the vehicle. Therefore the vehicle can also move on country and hilly roads without difficulty. The military vechicles and Jeep use four wheel drive.

Jeep has three forward speeds in main transmission. It has two-speed transfer case which provides two different gear ratios as well as a means of power distribution from the main transmission to the driving axles. The gear ratio change is made by a sliding gear which is moved by a shift force in the transfer case. An interlock is provided that prevents using the low gear ratio unless all the driving axles are engaged.

Generally all the four-wheelers use constant mesh and synchromesh-arrangement for gear box. Heavy vechicles like trucks generally have five forward speeds and one reverse speed. On the other hand, light vehicles like cars have four forward speeds and one reverse speed. Jeep has three forward speeds and one reverse speed along with an auxiliary gear box.

4.(a) Equipment :

1. Gear Boxes of four wheelers
2. Transfer case of Jeep
3. Gear Boxes of two wheelers
4. Crane
5. Jack

(b) Tools :

1. Spanner set double ended
2. Socket set
3. Ring spanner set
4. Punch set
5. Plier and lock plier
6. Screw driver set
7. Hammer
8. Torque wrench
9. Special tools kit

(as supplier by the manufacturers)

Constructional Features of a four forward and one reverse synchromesh gear box are shown in figure 7.1.1.

Constructional features of a two speed transfer case used an Willys Jeep are shown in figure 7.1.2.

Dis-assembly (Fiat)

1. Disconnect the necessary parts like speedmeter cable, clutch pedal linkage, gear linkage, dynamo connection, distributor wire, oil pipe, foundation bolts set, starter wire, propeller shaft etc. Then, open bell housing bolts.
2. Disconnect clutch linkage, speedometer gear linkage foundation, silencer bracket, propeller shaft, and housing bolts. Then take out gear box.
3. Drain out the oil
4. Disconnect the bell housing from the centre body.
5. Remove the speedometer support and drive shaft assembly.
6. Take off the transmission case top cover.
7. Remove the three screws and relevant plates of striker rod control forks.
8. Dismount transmission case near extension, take off the gasket, the primary shaft rear bearing, the bearing thrust ring and retainment ring.
9. Using special tool, unscrew the nut and relevant tab washer of primary shaft and then remove speedometer drive gear, and gear engagement sliding sleeve with.

the three shifting plates and the selector fork with relevant striker rod. Then, remove the Ist gear fork being careful not to drop the positioning ball which remains free.

10. Remove the shifting plates thrust ring, the sliding sleeve hub with shifting plates spring, the 2nd gear thrust ring, the synchronizer ring, the 2nd gear with its bush and the gear thrust ring.

11. With special tool remove layshaft front bearing nut and take off the tab washer.

12. From the rear withdraw the layshaft with 2nd speed gear.

13. Slide the selector control relay lever off its support pin.

14. Remove dog shaft self-locking nut, take off the cups and reverse control stiffening spring.

15. Remove the two screws and relevant plates securing the gear shifting control dogs. Slide off dog shaft and collect the dogs.

16. Remove the two ring seals from their seats in housing.

17. Take off : the 3rd, 4th and reverse striker rods with relevant forks and positioning balls.

18. Take off front cover with gasket and direct drive shaft seal.

19. Remove direct drive shaft with nut and bearing.

20. Remove primary shaft intermediate bearing retainment plate;

take off front roller bearing and then remove the two sliding sleeve stop semi rings.

21. Slide off primary shaft and pick up in the casing 4th geat synchronizer ring, Ist speed sliding gear with 3rd and 4th gear sliding sleeve with the three relevant shifting plates, sleeve hub with shifting plates spring, 3rd gear synchronizer, 3rd gear first thrust ring, the gear and the second thrust ring.

22. Remove the bearing retainment nut on direct drive shaft with special tool and then slide off the bearing.

23. Undo the reverse shaft retainment screw and take off the shaft with gear.

24. Remove the gear cluster on layshaft and drive the bearings off the casing.

Inspection (Fiat)

1. Clean the parts with kerosene oil.

2. Check the parts for wear and breakage.

3. Check the wear and seizure of the splined hole at sliding gear hub and there should not be any indentation on the edges of splines.

4. Check that the 3rd, 4th and 2nd gear engagement sliding sleeve hubs are free from any indents, particularly on the sliding surface of the sleeves. See that the clearance between sleeve guide groove flanks and corresponding

hub flanks does not exceed 0.08 to 0.12 mm. With a wear limit of 0.020 mm.

5. Check the primary shaft by dial indicator for any bend.

6. Check the reverse shaft and gear bushing. The clearance between reverse shaft and gear bushing should be between 0.035 to 0.080 mm.

7. Check ball and roller bearings for excessive play. The excessive play should not exceed 0.02 mm. radial or 0.2 mm. axial. It should not make any wire.

8. Check synchroniser rings and see that they are not damaged on the inner tapered surface and splines meshing with the sliding sleeves.

9. Check gear shifting selector forks and see that they are not deformed or indented.

10. Check the striker rods and see that they slide freely in their guide holes.

11. Check the seals for the wear or other damage.

12. Check the cracks etc. in the casing.

13. Replace the damaged and worn parts. Replace the all seals and gasket.

Assembly (Fiat)

1. Install layshaft rear roller bearing and front ball bearing in their seats in transmission case.
2. Install reverse shaft and sliding gear and secure reverse shaft with the screw.
3. Slide the gear cluster including constant mesh, Ist and 3rd speed gears into the case.
4. On the bench, partially assemble the primary shaft inserting on it the following parts : intermediate ball bearing, 3rd speed gear, first thrust ring, 3rd speed gear bush and gear, 3rd speed synchronizer ring, second thrust ring, 3rd and 4th speed sliding sleeve hub and hub lock semirings.
5. Install the primary shaft thus prepared in transmission case and secure the intermediate bearing plate.
6. From the rear end install the layshaft with 2nd speed gear.
7. Then, set in position the gear cluster previously installed and lock the layshaft tab washer and nut using special tool.
8. On primary shaft install in the order : 3rd and 4th gear sliding sleeve with Ist speed gear, placing shifting plates springs between sliding sleeve and splined hub; 4th speed synchronizer ring; primary shaft front roller bearing.

9. Take care, on installing the primary shaft components, not to dislodge accidentally the sliding sleeve shifting plates mounted between the splined hub and 3rd and 4th speed gear engagement sleeve.

10. On constant mesh shaft install the ball bearing, using tool. Tighten the nut with special tool then lock with tab washer.

11. Install the constant mesh shaft seal in the seat in cover and secure the cover to transmission central body after interposing the gasket.

12. On primary shaft rear end (outside central body) install in the order: 2nd gear first thrust ring, 2nd gear and bush, second thrust ring, 2nd gear synchronizer ring, splined hub with shifting plates between hub and sleeve, the shifting plates thrust ring and finally, the speedometer driving gear.

13. Fit the nut, tighten with wrench and lock with tab washer.

14. Install the 3rd and 4th selector forks and striker rods and secure forks to rods with screw and lock plate.

15. In the seats on casting install: dog shaft seats, dog shaft and, at the same time, inside casing, the two dogs for reverse, Ist, 2nd and 4th speeds.

16. Outside the casing insert: inner cup, reverse control stiffening spring and outer cup. Fit and tighten the self-locking nut.

17. Install the selector relay lever on its pin and secure with washer and cotter pin.

18. In the groove on primary shaft rear end fit the rear bearing retainment ring and snap ring.

19. Mount and secure the casing rear extension to central body.

20. Fit the primary shaft rear ball bearing in its seat on rear casing extension and push it against the lock ring.

21. On primary shaft install the rear seal. To install seal use special tool.

22. Install the centering ring on primary shaft and lock with snap ring.

23. Install speedometer drive assembly.

24. Secure bell housing to central body.

25. Insert in their seats the three striker rod positioning balls with relevant springs.

26. Remove the transmission assembly from stand, fit and tighten oil drain plug and fill with recommended oil.

27. Fit the filler plug on casing right side and install top cover.

28. Reverse the removal operation.

29. Tighten the self-locking nuts securing the flexible joint to parking brake drawn by using torque wrench.

30. Adjust the gear shifting linkage for easiness in shifting the gear.

Care should be taken while fitting the new synchroniser ring.

For Ambassador Section - F (gear box)

Fig.7.1.3 gives exploded view and name of parts (Fig.7.1.3.)

Dismantling :

1. Dismantle the engine, bellhousing, propeller shaft etc. as mentioned earlier in Fiat car dismantling experiment.
2. Remove the taper pin No.135 and both lever No.132 and shifter lever No.133 from gear box.
3. To remove layshaft No.79, take out locking screw No.88.
4. Take out all the components of gear box to the outside.
5. Remove the clutch fork shaft if there is any play in shaft and both (in bellhousing).

6. To remove 2nd gear wheel from main shaft press the plunger (gearlockwasher) No.67, with the help of steel wire and turn lock washer (gear) No. 66 and take out the 2nd gear wheel No. 63. The same procedure is adopted to 3rd gear wheel as mentioned above.

7. Clean and wash all the parts in cleaning solvent.

INSPECTION AND REPAIRS

1. Inspect the gear wheels, synchronisers, shims, ball-bearings and needles bushes, striking fork, key-shaft, main-shaft and springs, balls etc. for their excess play, wear etc.

2. Replace damaged, worn out broken parts while assembling.

3. Replace oil seals and packings as well.

ASSEMBLY :

1. Fit counter gear with roller bearing and spacer (keyshaft) with the steel and thrust washers.

2. Insert main shaft assembly and top gear shaft into the gear box housing properly after fitting new synchronising rings. Also insert reverse gear properly.

3. Fit main shaft bearing and speedometer gear with key. Then tighten the nut with the proper tool and lock the nut.

4. Fit layshaft in counter gear. Care must be taken that the thrust washer should not fall in casing. Tighten the counter gear shaft with locking bolt.

5. Fit extension casing along with plate and spring plates No. 44 and 45. Also insert main shaft rear bearing No. 47 with oil seal.

6. Fit universal joint flange No. 50 with steel washer. and tighten it as per recommended torque.

7. Lock the nut with split pin. Fit the fork and shifter shafts in the housing and tighten the forks with screw. After tightening the screw,lock the screw with wire.

NOTE : a) Care should be taken that the shifter shafts must move freely in their positions

b) The inter-lock bolts must be inserted in the housing before putting the shifter shafts

8. a) Put the main body cover with three bolts and three springs, new gasket and tighten the cover bolts properly.

b) Put extension casing cover and tighten it.

c) Insert glands No. 134 on cross shafts with levers and fit the taper pin properly.

d) Fit the speedometer pinion No.140 assembly with gasket in extension casing.

9. Fit the bell housing with gear box with a new gasket and new oil seal.

10. Fill the oil to the recommended level (use SAE 90 EP)

11. Fit the gearbox on to the vehicle and give linkage connections.

12. Lift the Engine and fit it on to the vehicle and give its connections.

13. After trial make necessary adjustment, if necessary.

Gear Box (Two Wheelers - Lambretta)

Description :

In two wheelers like Scooters and Motor cycles, it is three or four speed gearboxes. These gear boxes are constantmesh type. In Scooter, the gear ratio (speed) is changed by twist grip where as in motor cycles gear ratio is changed by left or right foot.

Dismantling

1. To dismantle the clutch plates, fit clutch puller to the clutch housing.
2. Remove lock ring with the help of screw driver.
3. Remove the puller from its place.
4. Take out the clutch, pressure plates and springs.

5. **Hold clutch bell housing with proper** tool & remove the nut after opening the thrust plate.

6. To remove inner & outer clutch bell housing, insert proper tool into the inner bell, refit the circlips & withdraw the inner bell. Then slide off the outer bell, the bush and the shims.

7. To remove chain & side guides, slide out the chain lock plate & unscrew the two bolts fixing the guide.

8. To remove the gear shaft-support flange, unscrew the six nuts which fix it to the crank case.

9. Withdraw cluster (main) gears with gears on lay shaft (counter shaft).

10. To remove the rear wheel & rear hub, loosen the hub nut, after removing the locking plate, remove the four dome nuts of the rim & take out the wheel after placing the engine on a stand. Remove the hub nut & withdraw the rear hub.

11. To remove the main shaft & pinch screw which fix the gear change lever shaft to the external lever, take out the lever shaft & tap out the main shaft with a plastic mallet (soft-Hammer).

12. Clean & wash the parts in cleaning solvent such as kerosene or parafin.

Inspection & Repairs

1. Check the gear teeth, gear splines & main shaft splines, bush & bearings. If necessary, replace them.
2. Check the gear changing dog for proper sliding, if any damage is found, replace it.
3. Check spring & balls for proper functioning.
4. Replace oil seals.
5. Check bell housing & crank case cover for any cracks or damage.

Assembly

Assemble all the parts in reverse order of dismentling. Fill the oil to the required level.

Gear Box (Two wheelers Bajaj & Jawa)

(Refer : Fig. 7.1.12 to 7.1.14)

Dismantling : (Bajaj & Jawa)

1. Disconnect all the cables & electrical connections from the engine side.
2. Drain the gear box oil through the drain plug & close the fuel supply.
3. Give the support to rear portion of the vehicle & remove the wheel.

4. Remove the shock absorber.
5. Take out foundation bolt between engine & chassis.
6. Take out the engine from the vehicle.
7. Remove the engine block.
8. Remove carburettor, magnet, clutch etc.
9. Separate the two halves of the engine using proper tools. Care should be taken that the parts should not get damaged.
10. Take out gear wheels from the two halves.
11. Clean & wash all the parts in cleaning solvent.

Inspection and Repair

1. Inspect different gears, selector assembly and sector etc. for wear.
2. Replace worn parts such as spring loaded balls, gear dog, gear splines etc. if necessary.
3. Replace oil seals & packings.
4. Change gear cables if necessary.

Assembly

1. Assemble all the parts in reverse order.
2. Care should be taken that while filling, the selector assembly must be in neutral position.

Trouble Shooting for two wheelers

Troubles	Causes	Remedies
1. Noisy gears	1. Improper clearance between shim & flange	1. Replace with suitable shims.
	2. Damaged gear wheel	2. Replace
	3. Wornout lay shaft & main shaft bearings	3. Replace
2. Hard gear Shifting	1. Improper cable adjustment	1. Adjust-properly
	2. Faulty inner lever	2. Replace
3. Slipping gears	1. Improper cable adjustment	1. Adjust-properly
	2. Gear selector worn out	2. Replace
	3. Selector spring weak	3. Replace
	4. Wornout linkage or Bushes	4. Replace

Questions : Two Wheelers

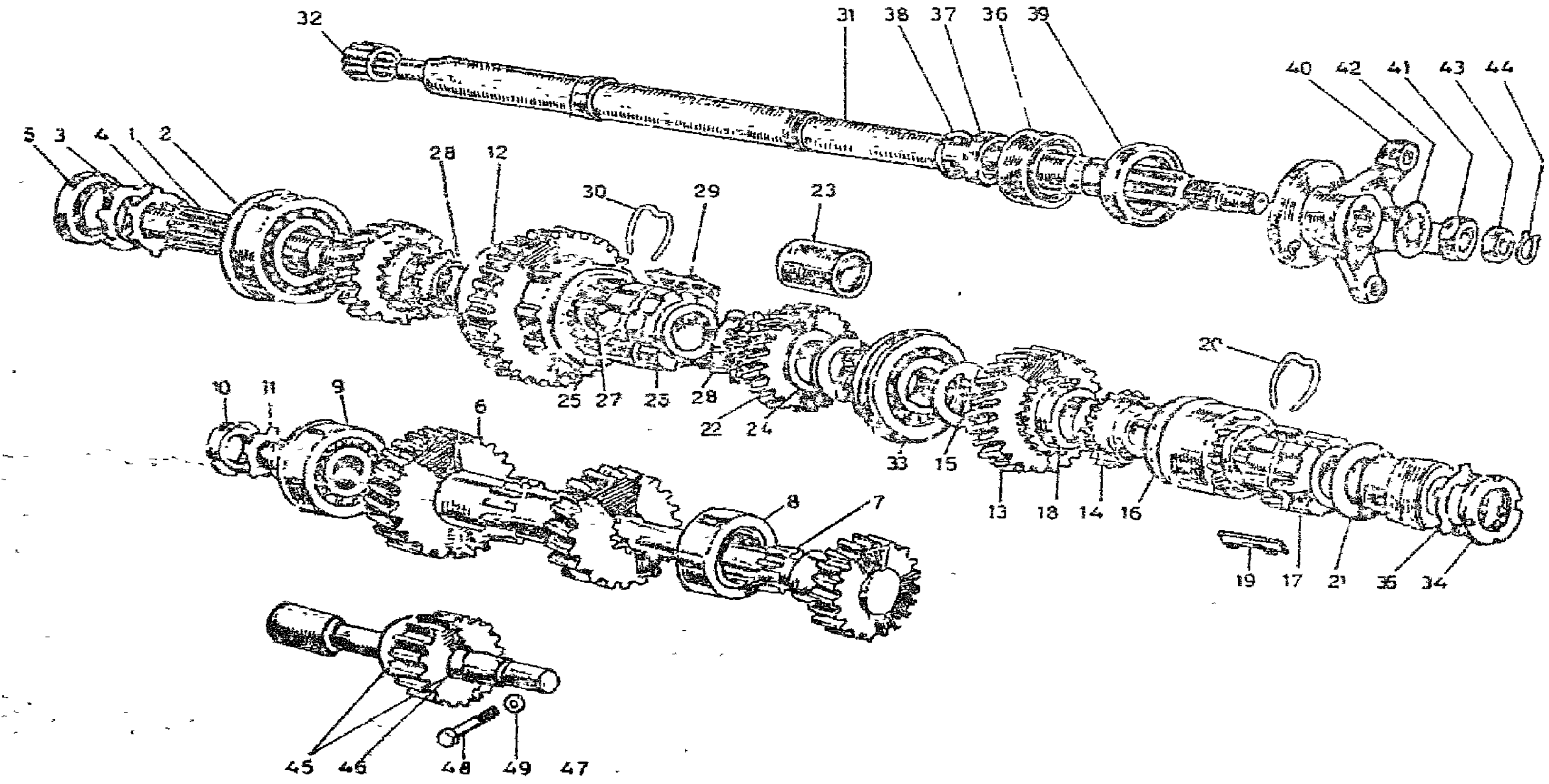
1. What are the different methods to change the gears in two wheelers ?
2. What are the different parts in Lambretta Scooter gear box ?
3. What is the grade of oil used in two wheeler gear box ?
4. What is the function of gear selector ?
5. What are the causes for noisy gear box ?
6. What are the remedies for gear slipping ?

Questions : Four wheelers

1. What is the purpose of gear box in a vehicle ?
2. What are the different types of transmission system ?
3. What is the difference between synchromesh and slidingmesh gear box ?
4. What is the grade of oil used in the gear box ?
5. What are the reasons for slipping gears ?
6. What are the reasons for sticking gears ?

/TARA/

FIG-7-1-1-TRANSMISSION GEARS



LEGEND OF FIG 7.1.1. TRANSMISSION GEARS

1. Drive Shaft, Constant mesh and top gear 10 splines
2. Bearing, Drive shaft ball
3. Nut, Bearing locking slotted
4. Washer, Tab
5. Seal, Constant mesh and fourth gear shaft
6. Gear, Layshaft constant mesh, first and third
7. Layshaft, With second gear
8. Bearing, Layshaft rear roller
9. Bearing, Layshaft front ball

10 Nut Slotted
11 Lockwasher
12 Gear, First and reverse
13 Gear, Second speed
14 Bush, Primary shaft second gear
15 Ring, Second speed gear thrust
16 Sleeve, Second speed gear sliding
17 Hub, Second gear sliding sleeve
18 Ring, Synchronizer
19 Plate, Second gear synchronizer ring shifting
20 Spring, Synchronizer ring shifting plate
21 Ring, Second speed gear locking plate thrust
22 Gear, Third speed
23 Bush, Third speed gear
24 Ring, Third speed gear thrust
25 Sleeve, Third and fourth speed gear sliding

26. Hub, Third and fourth speed gear sliding sleeve
27. Semi-ring, Third and fourth gear sliding sleeve stop
28. Ring, Synchronizer
29. Plate, Third and fourth gear synchronizer ring shifting
30. Spring, Synchronizer ring shifting plate
31. Shaft, Primary
32. Bearing, Roller primary shaft front
33. Bearing, Ball primary shaft intermediate
34. Nut, intermediate bearing shaft
35. Lock washer
36. Bearing, Primary shaft rear ball
37. Retainer, Primary shaft rear bearing
38. Snap Ring, Primary shaft rear bearing retainer locking
39. Seal, Primary shaft rear
40. Sleeve Assy., Primary shaft flexible coupling
41. Nut, Sleeve
42. Lockplate, Sleeve nut
43. Ring, Primary shaft flexible joint centering
44. Snap Ring
45. Gear Assy. Reverse idler
46. Bush, Reverse idler gear
47. Shaft, Reverse gear
48. Bolt, Reverse idler gear shaft
49. Washer

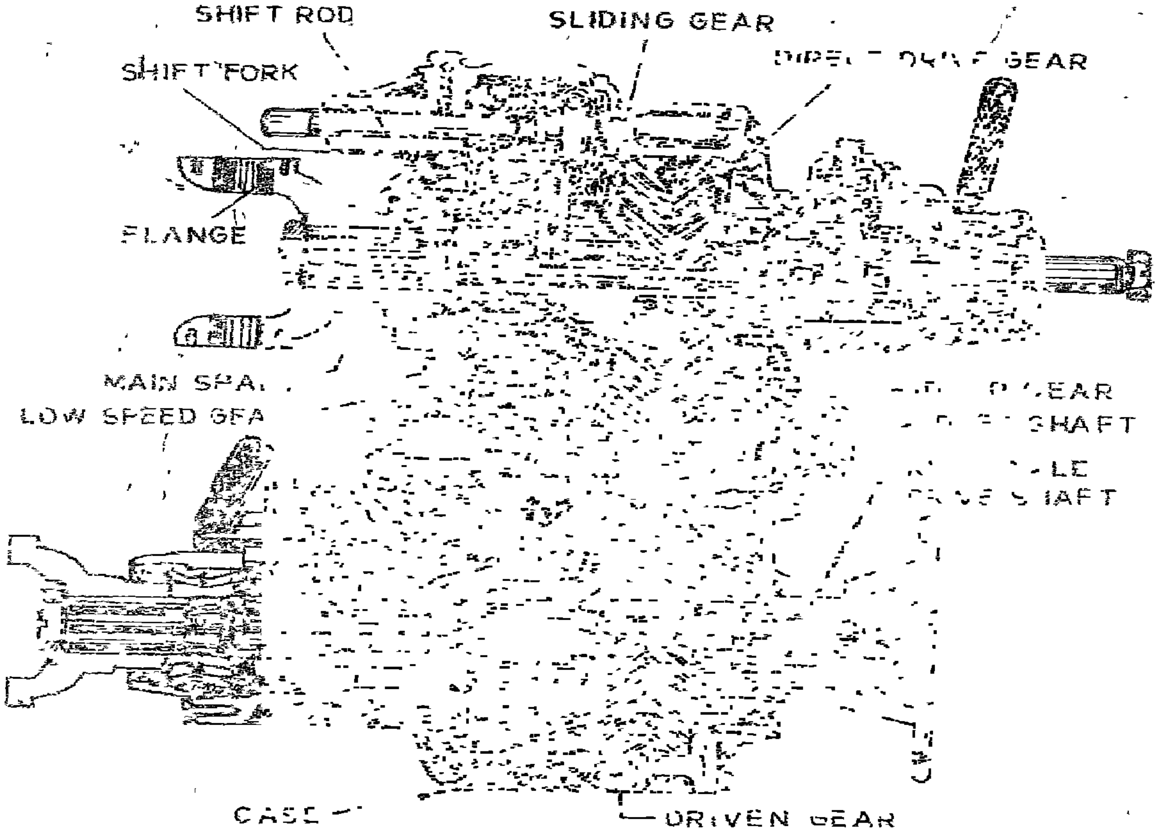
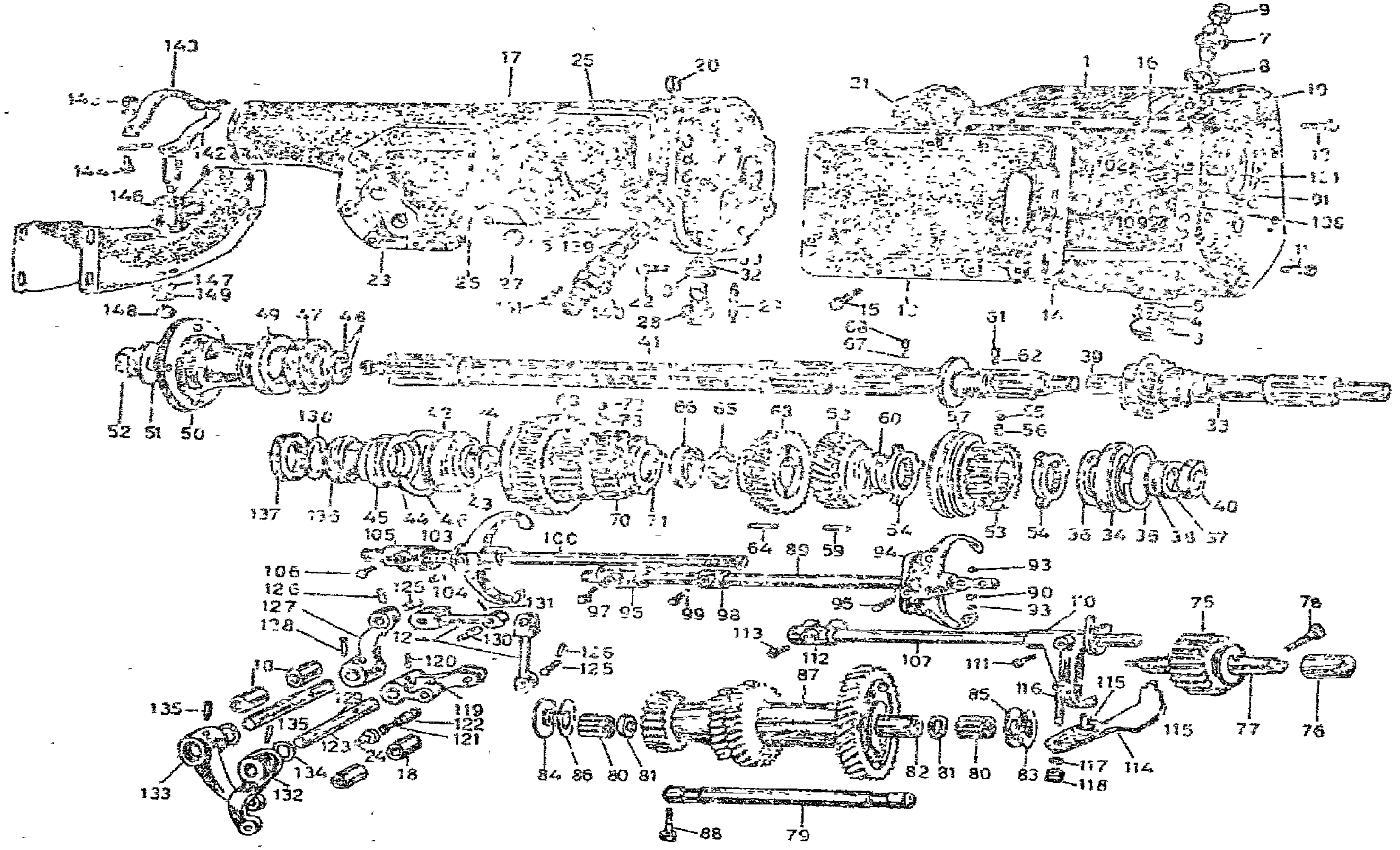


FIG:7.1.2 TWO SPEED TRANSFER CASE

FIG.-7·1·3 - THE GEARBOX COMPONENTS



LEGEND OF FIG. 7.1.3. NAME OF THE GEARBOX COMPONENTS

No.	Description
1.	Gearbox casing
2.	Stud-extension
3.	Plug-oil drain
4.	Washer-drain plug
5.	Circlip-drain plug
6.	Stud-casing cover
7.	Plug-oil filler
8.	Washer-filler plug
9.	Indicator-oil level
10.	Plug-interlock hole
11.	Bolt-short-gearbox to clutch
12.	Bolt-long-gearbox to clutch
13.	Cover-casing
14.	Joint-casing cover
15.	Bolt-casing cover
16.	Nut-cover-stud
17.	Extension-casing
18.	Bush-selector cross shaft
19.	Stud-side cover
20.	Nut-Extension stud
21.	Joint-extension
22.	Bolt-extension to gearbox
23.	Cover-extension side
24.	Insert-side cover
25.	Dowel-cover to extension
26.	Joint-side cover
27.	Nut-side cover stud
28.	Drain valve body
29.	Spindle-drain valve
30.	Plate-drain valve
31.	Washer-valve body
32.	Circlip-valve body
33.	Drive gear
34.	Bearing-drive gear
35.	Circlip-bearing
36.	Guard-bearing
37.	Nut-bearing
38.	Lock washer-bearing nut
39.	Roller-driving gear
40.	Oil seal-drive gear
41.	Mainshaft
42.	Bearing-front-mainshaft
43.	Guard-bearing-front
44.	Plate-bearing-front
45.	Spring-plate-bearing front
46.	Circlip-bearing-front
47.	Bearing-rear-mainshaft
48.	Collar-bearing rear
49.	Oil seal-bearing-rear
50.	Universal joint flange
51.	Washer-universal joint flange
52.	Nut-flange to mainshaft
53.	Sliding hub-top and 3rd
54.	Interceptor-top and 3rd
55.	Ball-sliding hub
56.	Spring-hub ball
57.	Striking dog-top and 3rd
58.	Third speed gear
59.	Roller-gear
60.	Lock plate-gear
61.	Plunger-gear lock plate
62.	Spring-plunger
63.	Second speed gear
64.	Roller-gear
65.	Washer-gear
66.	Lock washer-gear
67.	Plunger-gear lock washer
68.	Spring-plunger
69.	First speed gear
70.	Sliding hub 1st and 2nd
71.	Interceptor 1st and 2nd
72.	Ball-Sliding hub
73.	Spring-Sliding hub
74.	Distance collar-mainshaft
75.	Reverse gear
76.	Bush-reverse gear
77.	Shaft-reverse gear
78.	Screw-reverse shaft
79.	Layshaft
80.	Rollers-layshaft
81.	Washer-layshaft roller
82.	Spacer-layshaft
83.	Bearing plate-large-layshaft front
84.	Bearing plate-small-layshaft rear
85.	Thrust washer-large-layshaft front
86.	Thrust washer-small-layshaft rear
87.	Gear unit-layshaft
88.	Locating screw-layshaft
89.	Shifter shaft-top and 3rd
90.	Interlock pin-shaft

(Cont'd)

LEGEND OF FIG. 7.1.3. (Cont'd)

91. Ball-shifter shaft
92. Spring-shaft ball
93. Ball-interlock
94. Striking fork-top and 3rd
95. Screw-striking fork
96. Selector-top and 3rd
97. Screw-selector
98. Stop-fork
99. Screw-fork stop
100. Shifter shaft-1st and 2nd
101. Ball-Shifter shaft
102. Spring-shaft ball
103. Striking fork-1st and 2nd
104. Screw-striking fork
105. Selector-1st and 2nd
106. Screw-selector
107. Shifter shaft-reverse
108. Ball-Shifter shaft
109. Spring-shaft-ball
110. Shifter fork-reverse
111. Screw-Shifter fork
112. Selector-reverse
113. Screw-selector
114. Shifter lever-reverse
115. Pin-Shifter lever
116. Swivel-bolt-lever
117. Washer-Swivel bolt
118. Nut-swivel bolt
119. Selector lever-internal
120. Taper pin-lever
121. Plunger-lever
122. Spring-lever plunger
123. Cross shaft-lever
124. Connecting link-lever
125. Pin-link
126. Taper pin-link
127. Shift lever-internal
128. Taper pin-lever
129. Cross shaft-shift lever
130. Pin-Selector and shift lever
131. Taper pin-Selector and shift lever
132. Selector lever-external
133. Shifter lever-external
134. Gland washer-shift lever
135. Taper pin-external lever
136. Speedometer gear
137. Nut speedometer gear
138. Lock washer-gear nut
139. Speedometer pinion
140. Bearing-pinion
141. Sleeve-pinion bearing
142. Strap assembly-bottom-engine steady
143. Strap-top-engine steady
144. Bolt-strap
145. Nut-strap bolt
146. Bush-rubber-engine steady
147. Washer-special-engine steady
148. Nut-engine steady
149. Washer-shakeproof-engine steady

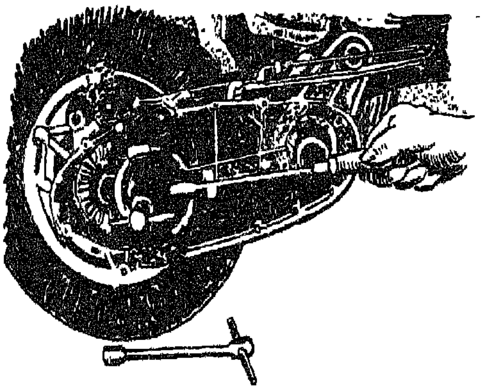
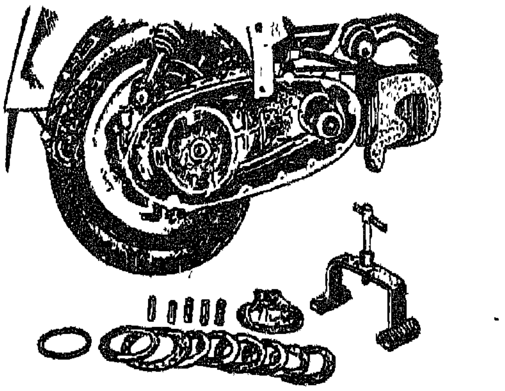


FIG NO-7.1.4. REMOVING LOCK RING FROM CLUTH ASSEMBLY.



F G NO-7.1.5

DIMENT LING CLUTCH UNIT WITH PULLER

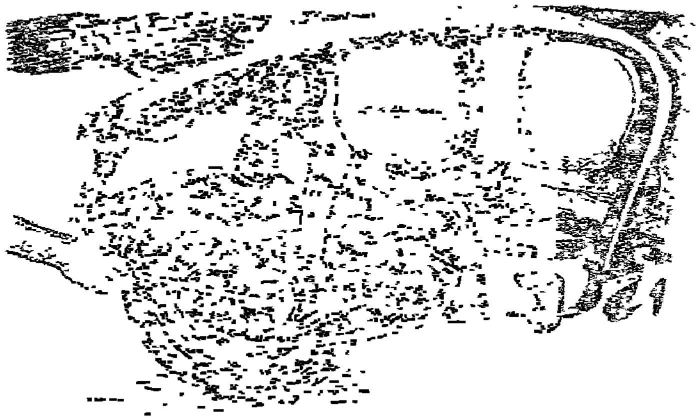


FIG NO -7.1.6 REMOVING NUT FROM CLUTCH UNIT

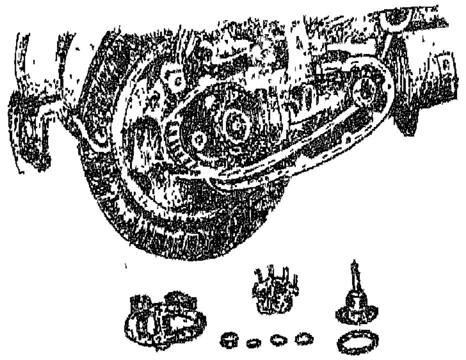


FIG. 7.1.7

DISMANTLING CLUTCH

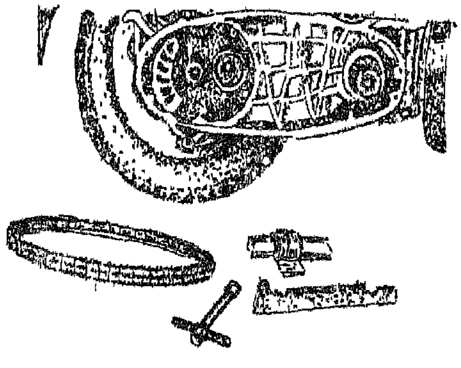


FIG 7.1.8

CHAIN AND SIDE GUIDES ARE REMOVED

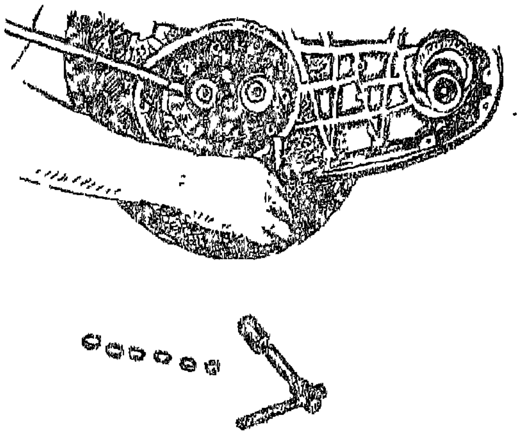


FIG 7.1.9

TO REMOVE THE GEAR SHAFT SUPPORT FLANGE UNSCREW THE SIX NUTS WHICH FIX IT TO CRANK CASE.

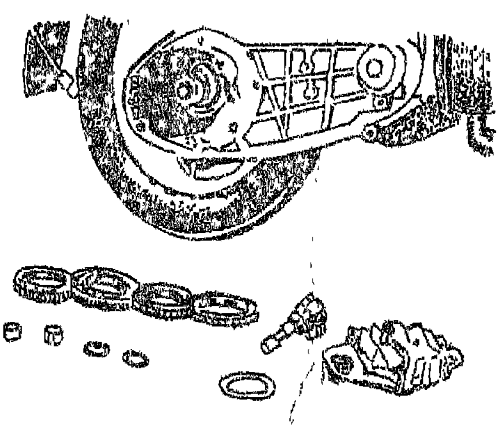


FIG. 7.1.10

DISMANTLING OF GEARS

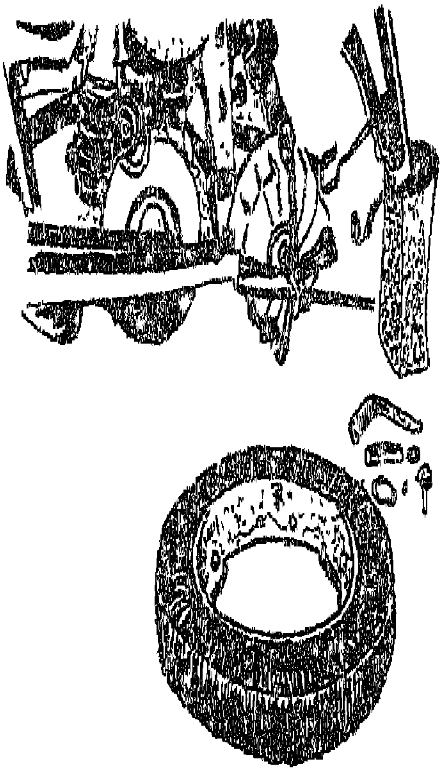


FIG 7.1.11

REMOVING REAR WHEEL DRUM BY PULLER

1 GEAR BOX HOUSING 2 MAIN SHAFT 3 SELECTOR
4 SELECTOR STEM 5 1st SPEED GEAR 6 2nd SPEED GEAR
7 3rd SPEED GEAR. 8 TOP SPEED GEAR 9 TOP SPEED GEAR.
10 MAIN SHAFT

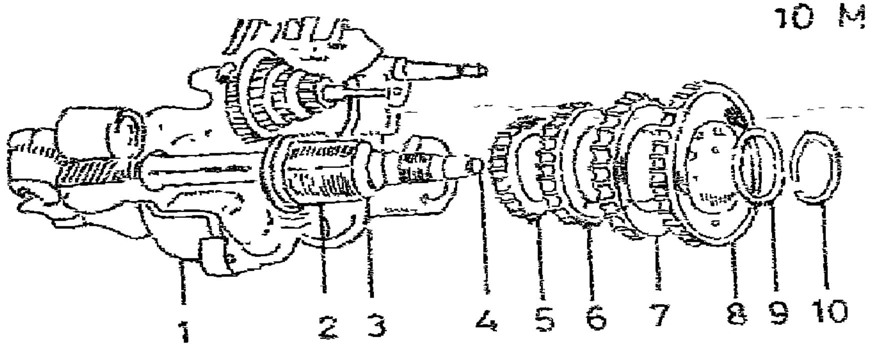


FIG NO-7.1.12 GEAR AND GEAR SHIFTING. ARRANGEMENT VESPA 4 SPEED MODLE

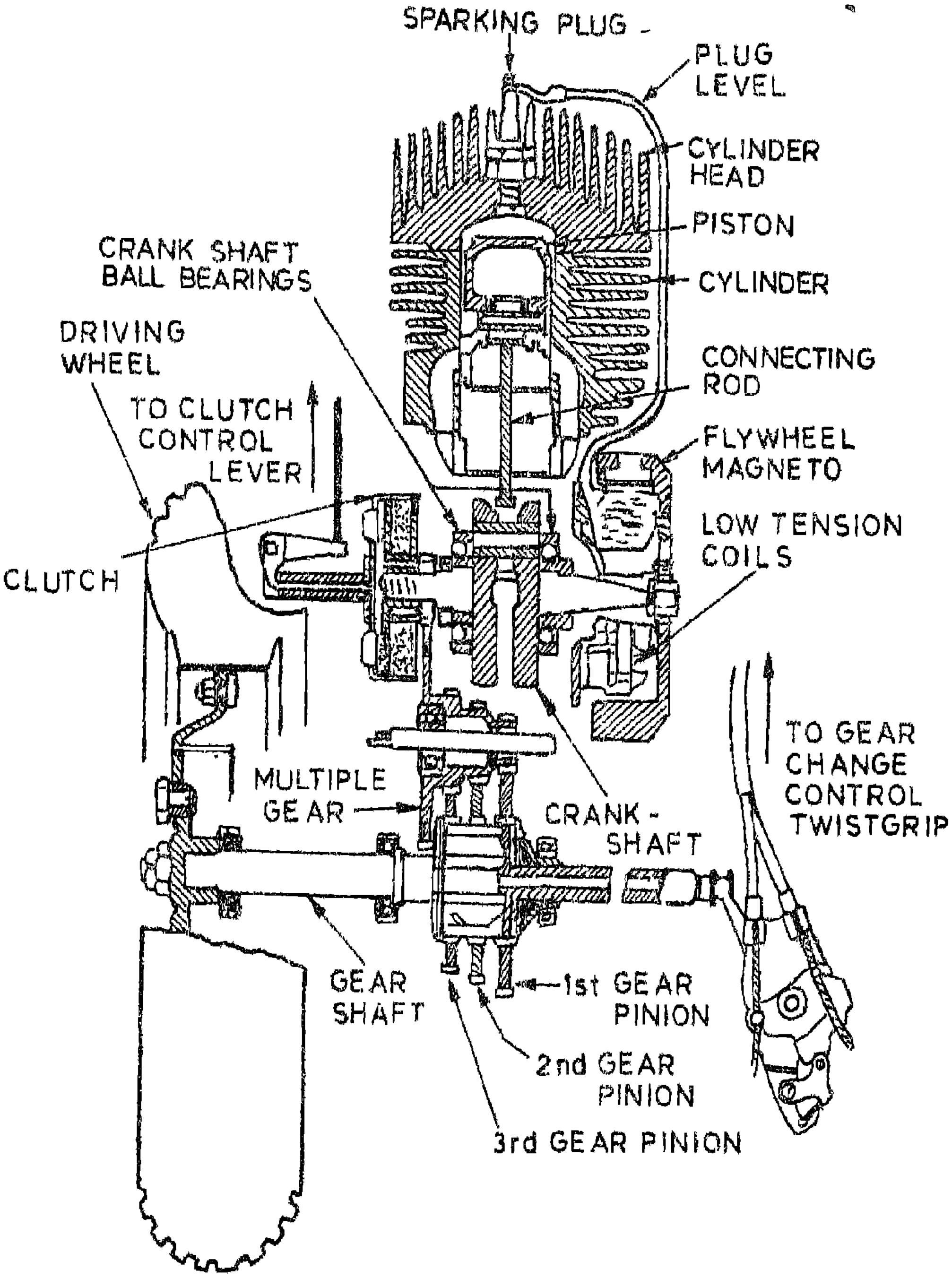


FIG NO-7.1.13 POWER TRAIN
BAJAJ SCOOTER.

1 PISTON
2.MAGNETO
3.FLEXIBLE CABLES
4.SELECTOR ASSEMBLY
5.STEM.
6.SECTOR.
7 1st SPEED GEAR
8.2nd SPEED GEAR
9.TOP SPEED GEAR
10.MAIN SHIFT

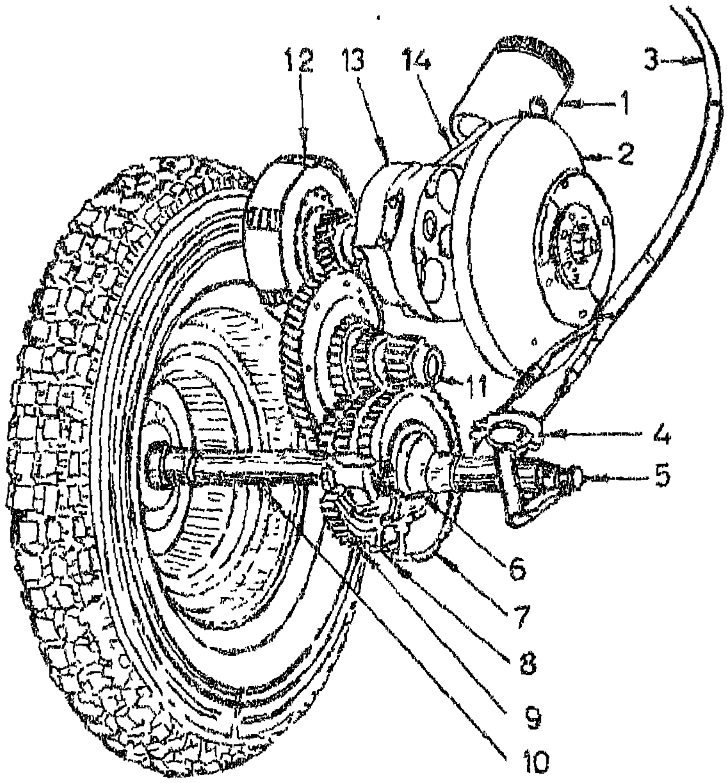


FIG NO-7.1.14 POWER TRAIN

BAJAJ

Experiment No. 8.1

General Objective : Study of transmission (connections) linkages

Specific Objectives :

(i) Study of universal joint

(ii) Study of slip joint

(iii) Study of propeller shaft.

Introduction

The universal joint consists of two yokes, one on the driving shaft and other on the driven shaft, and a cross shaped member called the spider. The four arms of the spider, known as trunnions, are assembed into bearings in the ends of the two shaft yokes.

The slip joint consists of outside splines on one shaft and matching internal splines on the mating shaft. The splines cause the two shafts to rotate together but permit the two to move endwise with each other. This accommodates any effective change of length of the propeller shaft due to the movement of rear Axle assembly.

The propeller shaft is the driving shaft that connect the gear box main or out put shaft to the final reduction at the axles. The propeller shaft may be either solid or hollow. All four wheel vehicles use hollow section and the Lamby, three wheeler use solid sections.

Tools Required:

1. Circlip plier
2. Hammer
3. Punch
4. Screw Driver and
5. Spanner Set.

Dismantling

1. Disconnect the bolts nuts and U-clamp(jeep) of universal joint of both sides.
2. Take out propeller shaft universal joints and slip joint from the vehicle.
3. For opening the universal joint, remove circlips, take out trunnion bearing (bearing cup) as shown in Fig. 8.1.3 and 8.1.4
4. Remove cross from the yoke
5. Clean and wash all the parts.

Inspection

1. Inspect slip joint splines for wear
2. Inspect propeller shaft for any bend.
3. Inspect cross for wear.
4. Replace worn and damaged parts.

Assembling

1. Assemble the needle rollers in the bearing races and fill with grease.
2. Fit the spider into the yoke of propeller shaft along with trunnion cups (bearing cups). Take care that needles do not fall down.
3. Put circlips into the groove above the cups.
4. Fit the grease nipples into the cross and slip joint.
5. Apply grease to the slip joint and fit both the male and female parts. Care must be taken that the balancing marks are aligned.
6. Fit complete assembly into the vehicle and tighten the bolts.

Trouble shooting

Trouble	Cause	Remedy
1. Noisy Drive	a) damage in needle bearing	Replace bearings
	b) Worn splines	Replace splined members
2. Vibration in the drive	a) Bent shaft	Replace shaft
	b) Loose flange bolts	Tighten them
	c) Excessive play in splines	Replace splined members
	d) unbalanced propeller shaft	Align the marks

Precautions :

1. See that the propeller shaft yokes are in alignment. (the yokes should be perpendicular to each other).
2. Lubricate the units at appropriate points periodically.
3. Never use old circlips and needles.

Review Questions

1. What are the purposes of propeller shaft, slip joint and universal joint?
2. If the propeller shaft is not properly balanced what will happen?
3. Why the propeller shaft is generally hollow?
4. If we do not use slip joint what will happen to the drive?

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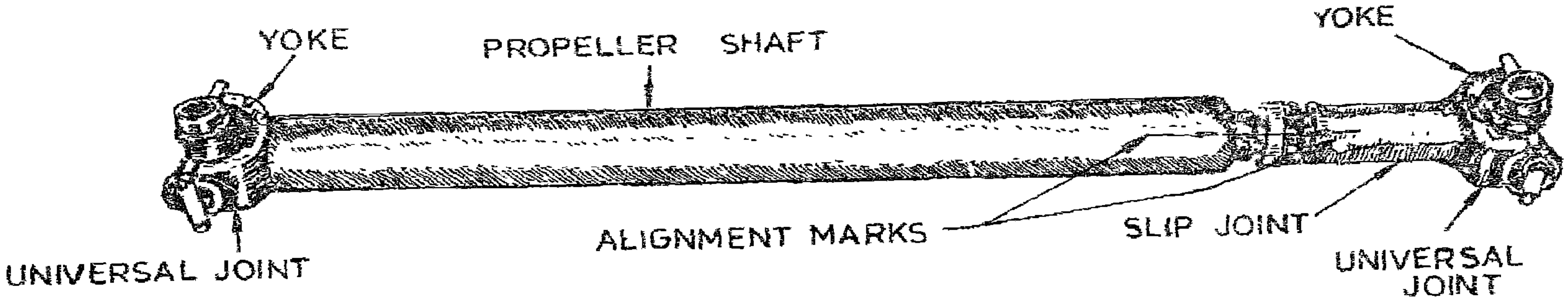
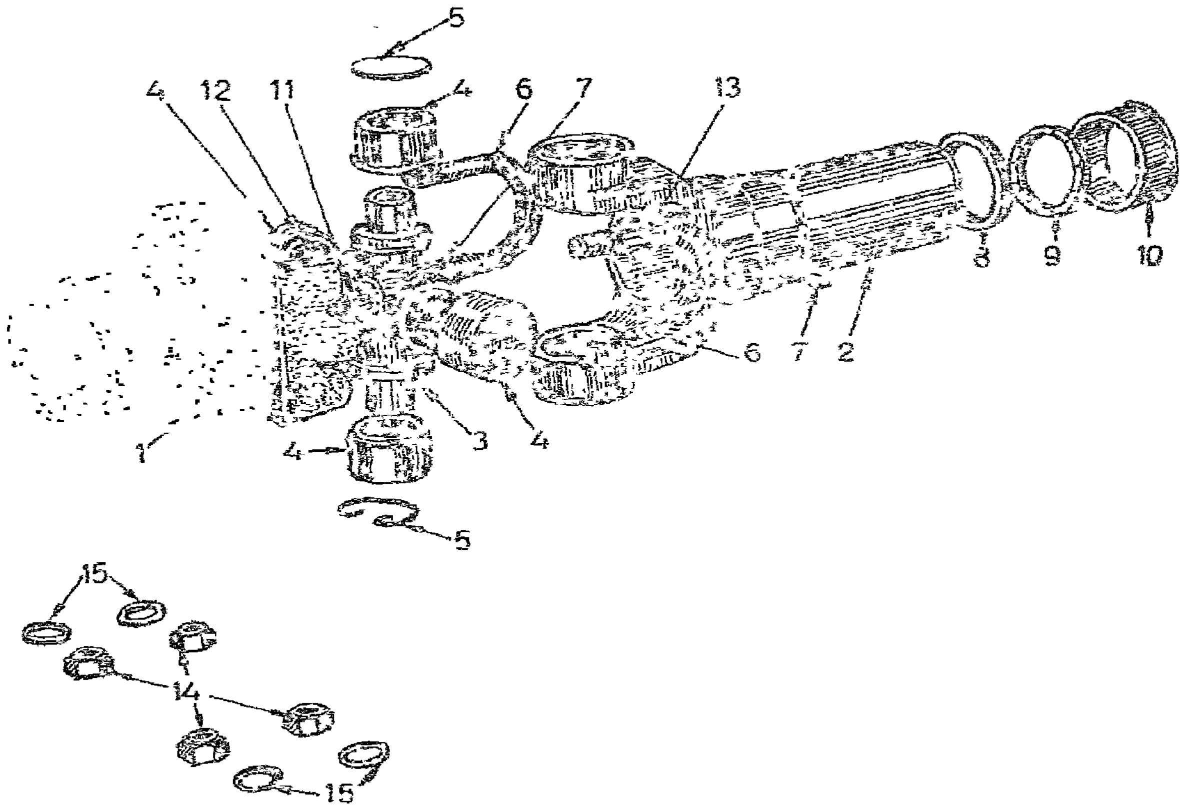


FIG NO-8.1.1 VARIABLE VELOCTIY UNIVERSAL JOINTS

FIG NO-8.1.2.CROSS AND YOKE TYPE UNIVERSAL JOINT



Legend of Fig. 8.1.2.

CROSS AND YOKE TYPE UNIVERSAL JOINT

1. Universal joint yoke.
2. Universal joint sleeve yoke.
3. Cross trunnion.
4. Trunnion bearing.
5. Trunnion bearing lick ring.
6. U-Bolt.
7. Lubrication fitting.
8. Oil seal.
9. Washer.
10. Packing retainer.
11. Relief valve.
12. Trunnion bearing rollers.
13. Air vent.
14. U-Bolt nuts.
15. U-Bolt washers.

FIG NO - 8.1.3 WHERE TO APPLY LIGHT BLOWS TO THE YOKE AFTER REMOVING THE RETAINING CIRCLIP

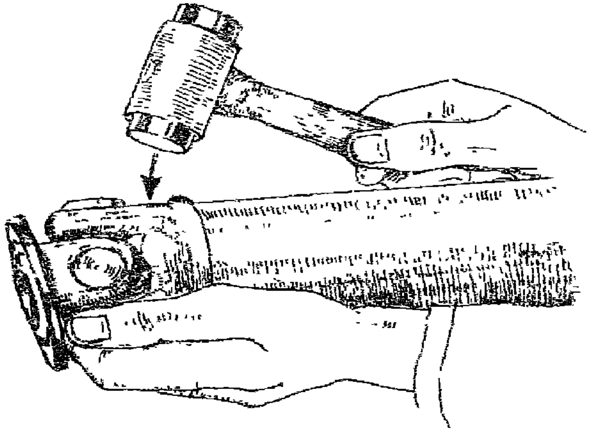


FIG NO - 813

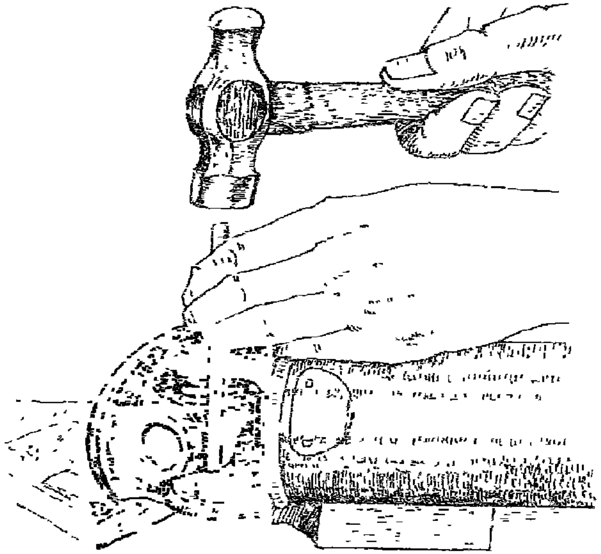


FIG NO - 81 4.

EXPERIMENT NO. 9.1

General Objective : Study of Rear Axle Assembly

Specific Objective :

1. To study the purpose, construction and operation of differential and axle.
2. To disassemble, inspect, adjust and assemble the Rear Axle Units.

Introduction :

The rear axle assembly includes the differential, rear axles shafts and bearings. The differential includes the tail pinion and the Crown wheel, where the final reduction at right angles takes place. The differential is a side gear assembly bolted to the side of the Crown wheel and rotates with it. The differential allows the rear Axle half shafts to rotate at different speeds but under same torque and comes into operation when the vehicle is taking a turn. On turns the outer wheel travels more distance than the inner wheel. In case, the differential is not provided, the inner wheel will be made to skid, as such there will be faster wear of tyres and tendency of overturning. When the vehicle is moving straight both the wheels should rotate at the same speed. In any case, the average speed of the two wheels is kept equal to the speed of the crown wheel.

Proper adjustment of the gears of final drive and differential gears is necessary otherwise the system will be out of order within a very short time. More backlash and noise are the usual symptoms of trouble in the final drive mechanisms. Axles are classified as live and Dead axles. Since the rear axle in most of the vehicles get the drive from the Power unit it is known as the Live axle. The live axle Carries a part of the vehicle load and drives the wheels as well.

There are three methods of supporting the half shafts in the rear axle case. They are Semi-floating, ¾ floating and fully floating. The inner end of the half shafts in all the cases are splined into and supported by sungears of the differential assembly.

In the Semi-floating axle arrangements, as adopted by cars and jeeps, the outer end of the axle shaft is supported in the axle housing by a single bearing. The wheel or hub is keyed on to the tapered portion at this end. The axle shaft is subjected to both bending and torsion.

In the fully floating axle arrangement, as adopted by Commercial vehicles, two tapered roller bearings are used between the outside of the axle housing and the wheel hub. The wheels are driven through splines at this end. The half shaft is arranged to transmit only the driving torque.

In case of the semifloating axle to remove the axle shafts the vehicle should be jacked up. Where as in Fully Floating arrangement the axle shaft can be removed without Jacking up the vehicle.

TOOLS REQUIRED :

1. Trolley Jack
2. Stands
3. Spanner set (Double end)
4. Ring spanner set
5. Hammer
6. Screw Driver
7. Socket set
8. Torque wrench
9. Plier
10. Puller
11. ial Gauge and
12. Special tools, recommended by the Manufacturer.

Differential of Fiat and Jeep

The view of the differential with the name of the parts is given below in fig. 9.1.1.

[illegible]

1. Park the car on the stands after lifting the jack. Drain out the oil from the housing.

Disassembly

1. Park the car on the proper stands. Place [illegible] jack. Drain out the oil from the [illegible].
2. Remove both the wheels; remove drums.
3. Take out the axle, shafts using puller.
4. Disconnect the propeller shaft.
5. Open the differential carrier bolts from the rear axle housing.
6. Take out final drive assembly and place it on the proper stand.
7. Open the bearing cap bolts of both sides and remove the ring gear pinion with differential cage assembly.
8. Open the drive pinion shaft nut and take out universal joint flange and drive pinion.
9. Open the ring gear bolts and disconnect the ring gear wheel.
10. Remove pinion shaft from the differential case and take out differential pinion and differential gears.
11. Clean and wash all the parts in kerosene.

INSPECTION

1. Check the differential and axle bearings for wear and indentation. Check the rear axle housing for [illegible] crack.

2. Check the differential case for any crack and ring gear flange run out. (Ref. Fig. 3.12)

3. Check crown wheel, star pinions, gears and pinion shaft for wear and cracks, if any.

4. Check the thrust washer for wear.

5. Check drive pinion flange for wear.

6. Replace the differential carrier gasket oil seal and worn out or broken parts.

7. Check the axle shafts. If the axle shaft is bent or splines worn out, replace it. Replace their bearing, if necessary.

Assembly

1. Fit the outer and inner cone in the differential carrier,

2. Check the pinion through washer [illegible] as shown in fig:- 9.1.3 to Fig. 9.1.5. [illegible] the method of the calculation shown under fig. 9.1.6 and

   Fig. 9.1.6.
   Fig. 9.1.3.
   Fig. 9.1.4.
   Fig. 9.1.5.
   Fig. 9.1.6. & Table.

3. Fit the drive pinion with thrust washer and the bearings on the cones with the spacer in between. The bearing should be fitted after lubricating their fitting surface. Use new spacer and self locking nut.

4. Fix the new seal in the body and then fit the flange and tighten the nut with torque wrench as per specification. Preload the above fitted bearing and check it. (Refer fig. 9.1.7. to 9.1.9.)

5. Fit the side gears with thrust washers. Fit star pinions and then insert star pinion shaft.

6. Fit the ring gear on the differential case and tighten the bolts with torque wrench at proper torque. See

that ring gear and pinion gear are properly matched.

7. Fit both the side bearings on the case after lubricating their fitting surface.

8. Fit the differential case assembly on the differential carrier.

9. Fit both side bearing caps and tighten the bolts.

10. Fit both the side cases and fit the bearing adjuster nuts. With special tool check the backlash of the drive pinion and ring gear. Adjust it with the help of adjuster nuts as shown in fig. 9.1.10. and lock them.

11. Apply red lead paste on the ring gear and rotate the drive flange. By this we get the pattern on the contact surfaces of the teeth. Examine the pattern as shown in Fig. 9.1.11. and make the adjustments indicated in the figure.

12. Fit the final drive assembly on the rear axle housing (use fresh gasket) and tighten the bolts with proper torque. Attach the drive line.

13. Fit one side of rear axle and its bearing with brake shoe plate. Fit new oil seal.

14. Pour the oil in the other side for differential as per requirement (Grade E.P. 90)

15. Fit other side rear axle and its bearing with brake shoe plate. Fit new oil seal.

16. Tighten plate bolts and nuts with brake drums on both sides of axle and tighten axle nuts with torque wrench.

17. Fit the split pin in the nuts.

18. Mount both the wheels.

Differential of Ambassador:

The exploded view in shown in fig. 9.1.12 and list of parts is given in the adjoining table.

Example (2) Old: "C" .002 in. - "D" .003 in.

= -.001 in.

New "C" .001 in. - "D" .005 in.

= -.004 in.

The old resultant [illegible] greater by .005 in., therefore the new spacer must be .005 in. thicker than the old one.

(B) ASSEMBLING DIFFERENTIAL AND CROWN WHEEL

The differential is assembled by first inserting the differential gears inside the differential cage with their thrust washers in position.

Note :- When new washers are fitted it is necessary to see that they are properly bedded in or it may be difficult to insert the pinions.

The differential pinions are next inserted through the opening of the cage with their distance-piece and thrust washers. The pinions are then rotated in the cage until they register with the holes in the cage for the shaft.

The pinion spindle, which should be a light push-fit in the cage, is then inserted, taking care to line up the locking bolt holes.

NOTE:- The slot in the shift [illegible] [illegible]. Fit the locking bolt and turn up the [illegible] [illegible] locking washer.

Fit the crown wheel to the [illegible] [illegible] after making sure that the [illegible] [illegible] clean and the [illegible] free from [illegible].

Check the crown wheel for truth by mounting the assembly on a roller fixture with a dial gauge registering against the outer edge of the crown wheel. The maximum permissible error of alignment is .001 in. (.025 mm.), and if the figure recorded is in excess of this the crown wheel should be removed from the differential cage and the flange of the cage checked for truth. If necessary, fit a replacement cage.

Provided the flange is true within the permissible error, clean all parts carefully and reassemble the crown wheel to the cage in a different position to that in which it was first assembled and checked, then re-check. This process should be repeated several times before finally deciding to discard the crown wheel and pinion.

The differential ball races can now be pressed on. If a new crown wheel or differential cage has been fitted it is essential to measure the "C" dimensions over the differential ball races, and "D" dimensions from the crown wheel back face to the right-hand bearing outer race outside face.

(C) TO REPLACE PINION.

(a) The old pinion in a new axle casing.

(b) New pinion and new matched set of bearings and distance-piece in an old casing.

(c) New pinion and old bearings and distance-piece in an old casing.

(D) Old pinion and new matched set of bearings and distance-piece in an old casing.

In all cases the pinion must be set accurately in the axle casing, remembering that the roller races and their distance-pieces are supplied in sets giving the correct amount of pre-load on assembly. They can, therefore, only be replaced as "Sets" and not individually.

The pinions may be marked on their heads with one of the following figures:-

A ringed figure +2, +1, Zero (or no marking), -1, -2, and possibly an unringed figure -2 or -1.

The pinion washer controls the position of the pinion in relation to the axis of the [illegible], and it is fitted between the head [illegible] its rear bearing.

Adjustment of the pinion position is made by varying the thickness of the pinion washer. These are available in a range of thicknesses [illegible] .001 in. (.025 mm.) and are marked in [illegible] only.

The pinion is fitted to the axle in the following way:-

Fit the pinion bearing outer races in the pinion housing, then assemble the rear pinion bearing inner race to the special dummy pinion spindle and place in position in the housing, inserting it through the cover opening in the axle casing.

Fit the front bearing inner race. (The bearing spacer is omitted, because the correct pre-load can only be obtained with the bearing in position when the universal joint flange is locked up right. The is due to the calculated compression of the bearing spacer under this locking load.)

Fit the spindle nut and tighten it up to give the correct pre-load of 11 to 13 in./lb. (.126 to 148 m./kg.) to the bearings.

Rotate the spindle eight or ten times to seat the bearings.

Fit the checking fixture in the axle cover opening and make sure that the locating arm makes firm contact with the side of the dummy spindle head. (see Fig. D.1.17)

This leaves a gap between the dummy pinion head and the checking anvil of the fixture, and this is the actual thickness of the pinion washer required for a standard pinion or one that has no marking.

Select a washer which will just slide between these faces and fit it behind the pinion head when re-assembling.

To assist manufacturing conditions it is occasionally necessary that a pinion be assembled away from the standard position. If this is so the variation is marked on the pinion head in a ring such as (+2), the sign + meaning that the centres are increased by .002 in. Correction has to be made for this, and when the figure is +(Plus) the amount must be taken from the washer thickness and if the figure is - (minus), then the amount has to be added to the washer thickness.

Example (a) A washer fitting the gap of the dummy pinion with a marking of .127 must be replaced by a washer having the marking .129 when refitting a pinion with the marking - 2 or -.002.

Example (b) A washer fitting the [illegible] of the dummy pinion bearing the marked .137 must be replaced by a washer marked .139 when the pinion is marked [illegible] +.002 on its head.

Disassembly

1. Jack up the car and put stands under the body and drain out the oil of differential.
2. Remove the wheels and take drum by removing axle nuts. Use puller for removing the drum.
3. Disconnect hand brake cables.
4. Disconnect the brake plates from the axle housing. Disconnect the rear pipe line from the axle housing body.
5. Open the U-bolts and take out axle housing tube.
6. Take out both side axles.
7. Open nuts of axle of axle cover studs and remove L/H axle tube and cover assembly.
8. Take out ring gear pinion and differential cage assembly.

9. Open the nut after removing the quarter pin. (Hold the flange with special tool).

10. Remove the flange with the help of puller.

11. Remove the pinion and bearing.

12. Take out locking bolt from the cage housing.

13. Remove pinion pin from the cage and dismantle the pinion along with thrust washers.

14. Clean and wash all the parts in kerosene oil.

Inspection

It is same as for Fiat.

Assembly

Assemble all the parts in the reverse order of disassembly and make different adjustment as given below.

(Refer Fig. 9.1.13 to 9.1.17)

Trouble Shooting

Trouble	Cause	Remedy
1. Noisy Differential	a) No lubricating oil in the differential housing.	Fill the oil
	b) Use of poor quality oil	Use specified oil.
	c) Wornout or damaged bearing.	Replace
	d) Wornout or broken teeth of crown wheel, driving pinion, or star pinion and side gear.	Replace
	e) Less backlash between ring gear and pinion teeth.	Adjust
2. Vehicle does not move when put on gear.	1) Broken propeller shaft	Replace
	2) Broken axle shaft	Replace
	3) Broken teeth on ring gear; drive pinion or star pinion and sun gear	Replace

Questions

1. What is the necessity of differential in and automobile ?

2. How can wear of the ring gear and pinion be remedied ?

3. How do you adjust - crown wheel and pinion ?

4. What are the causes for noisy differential ?

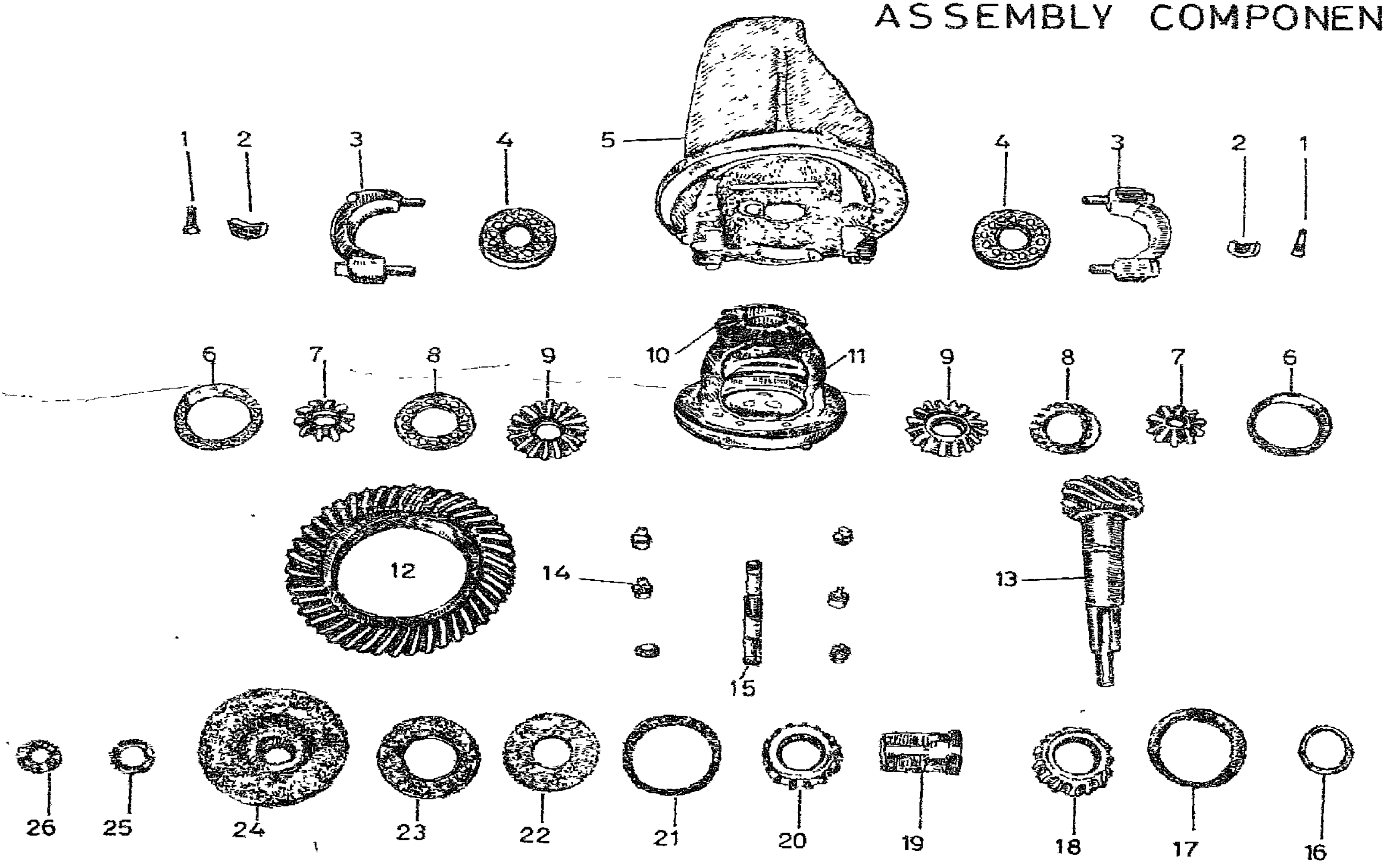
/TARA/

Le-g-end of Fig. 901.1

Final drive and differential assembly components.

1. Adjuster lock plate screws
2) Side roller bearing adjuster lock plates.
3. Differential case-to-carriercaps.
4) Side roller bearing adjusters
5. Differential carrier.
6) Roller bearing outer caps
7 Idle pinions
8) Side gear thrust washers.
9. Side gears.
10)Differential case roller bearing inner ring.
11.Differential case
12)Ring gear.
13.Drive pinion
14)Ring gear-to-differential case screws.
15.Idle pinion shaft.
16)Drive pinion rear bearing thrust washer.
17.Roller bearing outer ring
18)Drive pinion rear roller bearing inner ring.
19.Collapsible spacer
20)Drive pinion front roller bearing inner ring
21.Roller bearing outer ring.
22)Oil slinger.
23.Oil seal.
24)Drive pinion end flange
25.Pinion flange lockwasher
26)Self-Locking nut.

FIG NO - 9.1.1 REAR AXLE - FINAL DRIVE AND DIFFERENTIAL ASSEMBLY COMPONENTS



(A) TO REPLACE A DIFFERENTIAL CAGE

Selecting an axle casing spacer

All differential cages are stamped with two letters - "C" and "D" - together with a figure. The prefix "C" indicates the dimension over the differential bearings and the dimensional range is from 0 in. to .012 in. "D" indicates the dimension from the crown wheel back face to the outside face of the right-hand bearing outer race and the range is from 0 in. to +.006 in.

Differntial cages can be interchanged by applying the following procedure :-

Balance the "D" dimensions of the two cages and from the result select differnetial bearing spacers which will produce the same final location of the crown wheel on assembly.

Example (1) If the "D" dimension of the old cage was 005 in. and the "D" dimension on the new cage is .002 in., giving a difference of +.003 in., then this difference must be added to the old spacer thickness.

That is to say, if the old spacer is marked .503 in. the new spacer must be .506 in . thick.

Example (2) If the "D" dimension of the old cage was .001 in. and the "D" dimension on the new cage is [illegible] in., giving a difference of - [illegible] in., this difference must be subtracted from the original spacer thickness. That is to say, if the old spacer was [illegible] in. thick, then the new spacer must be [illegible] in. thick.

Selecting an axle cover spacer

In this case subtract the "D" dimension from the "C" dimension on both the old and the new differential cages.

If the resultant of the dimensions on the new cage is greater than that on the old one, the new spacer for the axle cover is less than the old one by the difference and vice-versa.

Example (1) Old: "C" .006 in. - "D" [illegible] in.

= .001 in.

New "C" .007 in. - "D" .002 in.

= .005 in.

The resultant with the new cage is the greater by .004 in., therefore the new spacer should be .004 in. less in thickness than the old one.

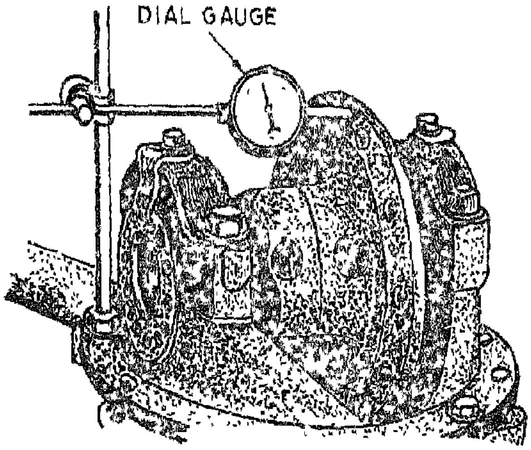
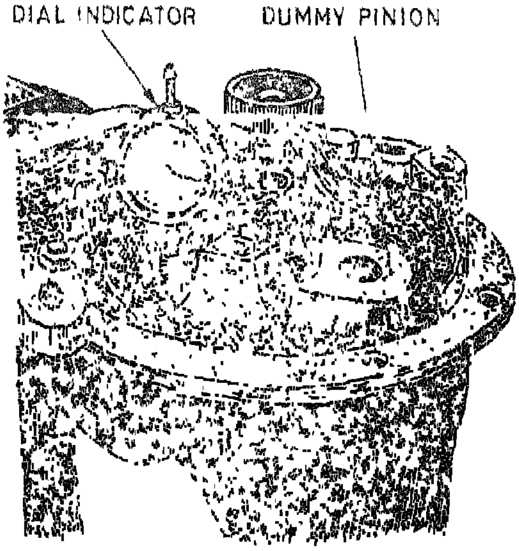


FIG NO - 9 1.2 CHECKING RING GEAR MOUNTING FLANGE RUN OUT



F I G NO - 9.1.3 DETERMINING BEVEL PININN REAR BEARING SHIM THICKNESS USING DIAL GAUGE ON DUMMY PINION

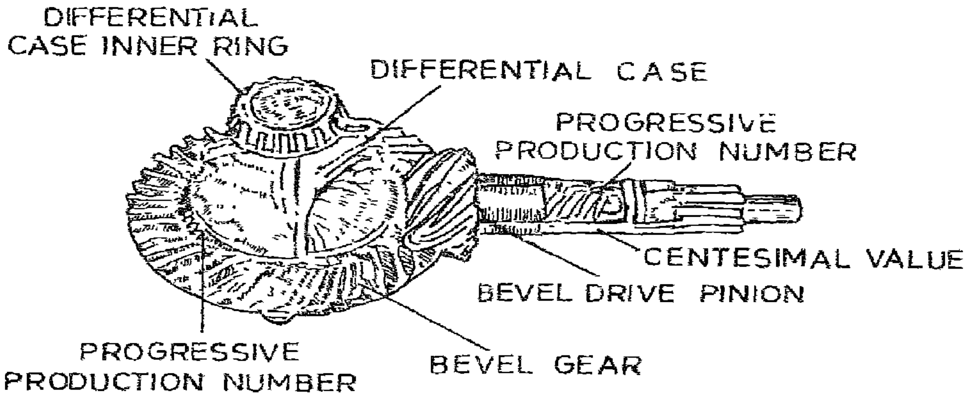

DIFFERENTIAL CASE INNER RING
DIFFERENTIAL CASE
PROGRESSIVE PRODUCTION NUMBER
CENTESIMAL VALUE
BEVEL DRIVE PINION
PROGRESSIVE PRODUCTION NUMBER
BEVEL GEAR

FIG NO-9.1.4 FINAL DRIVE PINION, RING GEAR AND DIFFERENTIAL INNER CASE

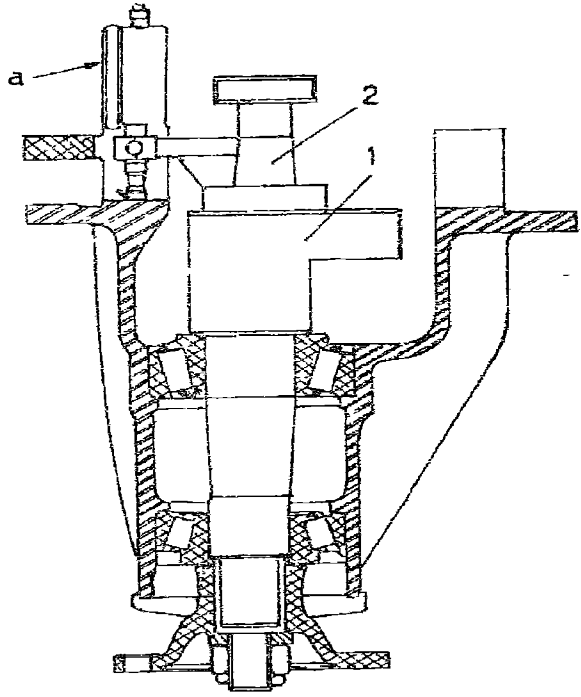


FIG NO - 9 1 5 DIAGRAM SHOWING HOW DUMMY PINION AND FIXTURE WITH DIAL INDICATOR MUST BE INSTALLED TO DETERMINE SHIM THICKNESS

1 DUMMY PINION

2.a DIAL INDCATOR

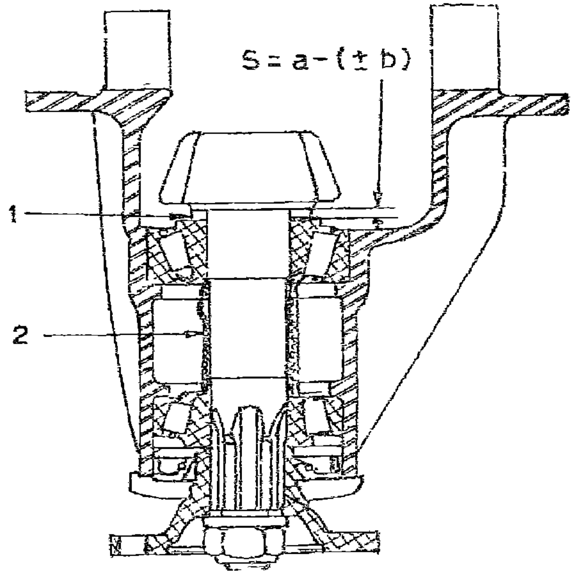


FIG NO- 9.1.6 DIAGRAM OF PINION ASSEMBLY

1 THRUST RING

2 COLLAPSIBLE SPACER

S THRUST RING THICKNESS

a DIAL INDICATOR

b VALUE STAMPED ON BEVEL PINION

HOW TO DETERMINE
BEVEL DRIVE PINION THRUST RING THICKNESS

If (a) is the reading on dial indicator (Figs. 9.1.3 - 9.1.4) and (b) the value stamped on pinion (Fig 9.1.4) thickness (S) of thrust ring to be fitted is obtained as follows :-

$$S = a - (+b) = a - b$$

$$\text{or} \quad S = a - (-b) = a + b$$

In other words :

- If number on pinion is preceded by sign plus (+) the thickness of thrust ring is obtained by substracting the number from dial indicator reading;

- Instead, if number on pinion is preceded by sign minus (-) the thickness of thrust ring is obtained by adding the number to dial indicator reading.

Example :- if $a = 2.90$ mm dial indicator reading, and
$b = -5$ mm. number on pinion
then $S = a - (-b)$
$S = 2.90 - (-0.05)$
$S = 2.90 + 0.05$
$S = 2.95$

Hence in case as this, a 2.95 mm. thick thrust ring should be fitted.

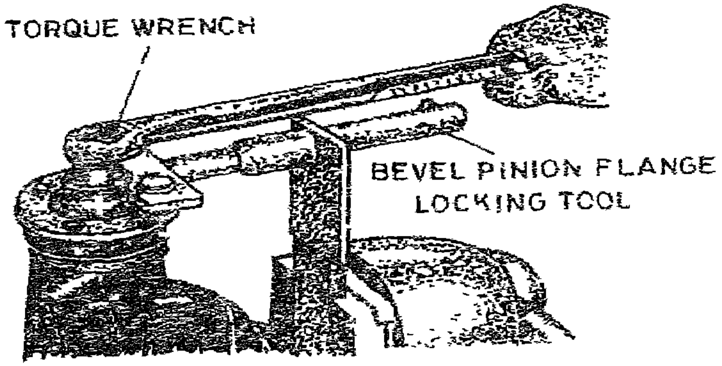

TORQUE WRENCH
BEVEL PINION FLANGE LOCKING TOOL

FIG NO -9 1.7 THIGHTENING THE SLEEVE-TO-PENION MOUNTING NUT WITH TORQUE WRENCH THE TORQUE MUST RANGE BETWEEN 8000 AND 16000 KG mm

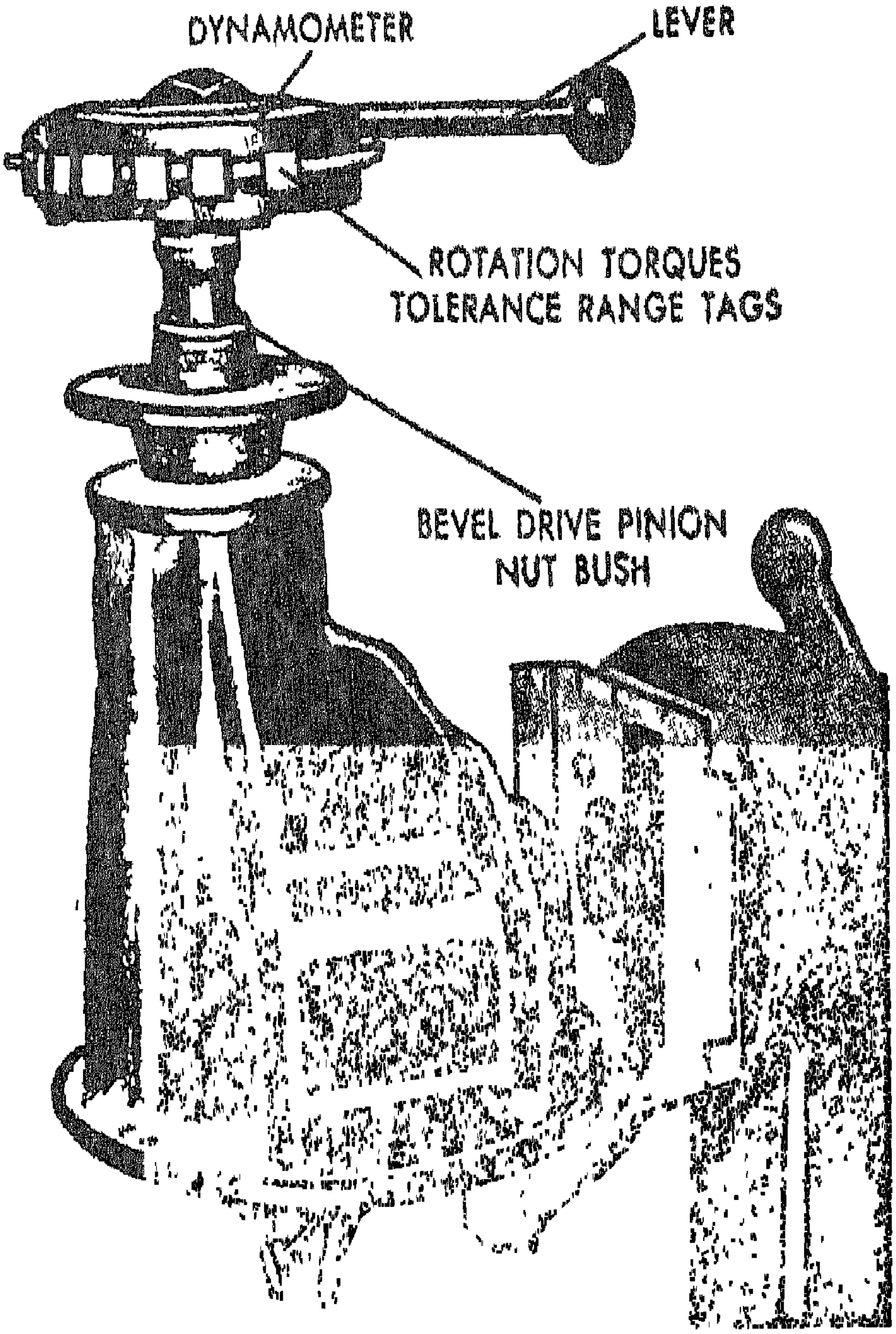

DYNAMOMETER
LEVER
ROTATION TORQUES TOLERANCE RANGE TAGS
BEVEL DRIVE PINION NUT BUSH

Fig.9·1·8 —Checking the pinion roller bearing preload, using dynamometer
The torque must range between 0.14 and 0.18 kgm.

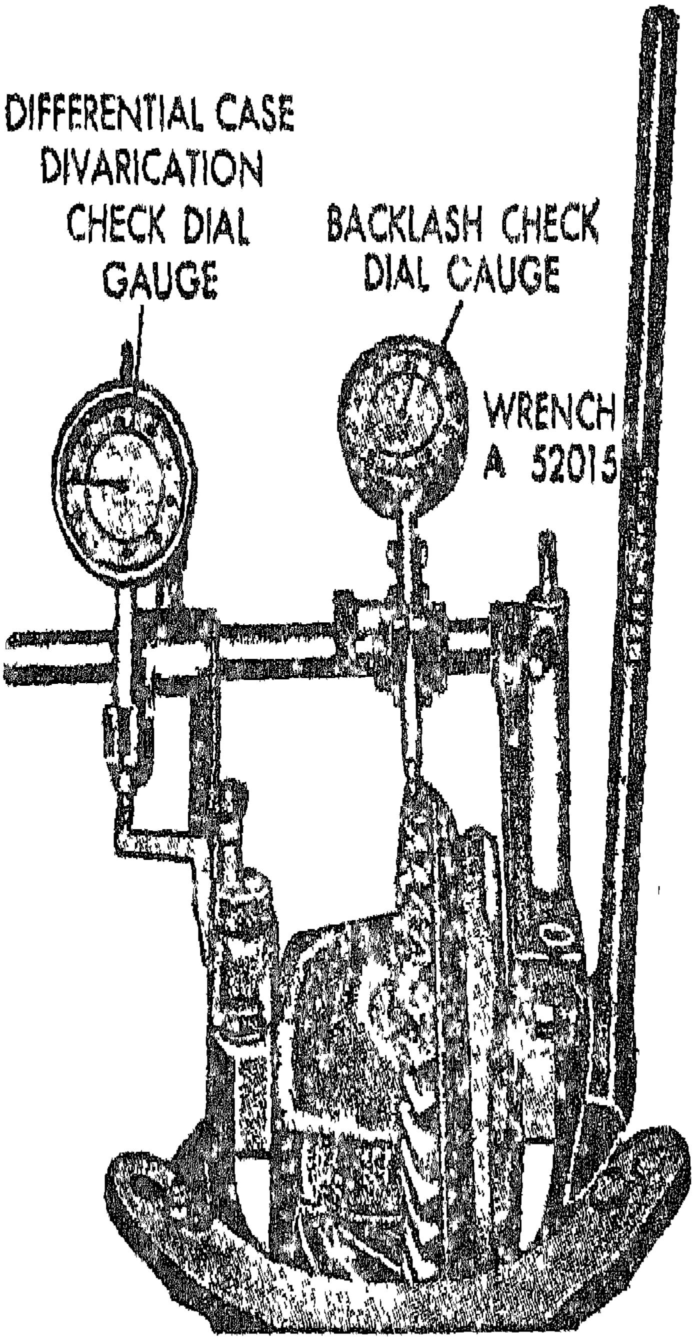

DIFFERENTIAL CASE DIVARICATION CHECK DIAL GAUGE
BACKLASH CHECK DIAL CAUGE
WRENCH A 52015

Fig. 9·1·9—Preloading differential inner case roller bearings by tightening the side adjusters with wrench. Preload (differential carrier cap divarication) is checked by by fixture shown above.

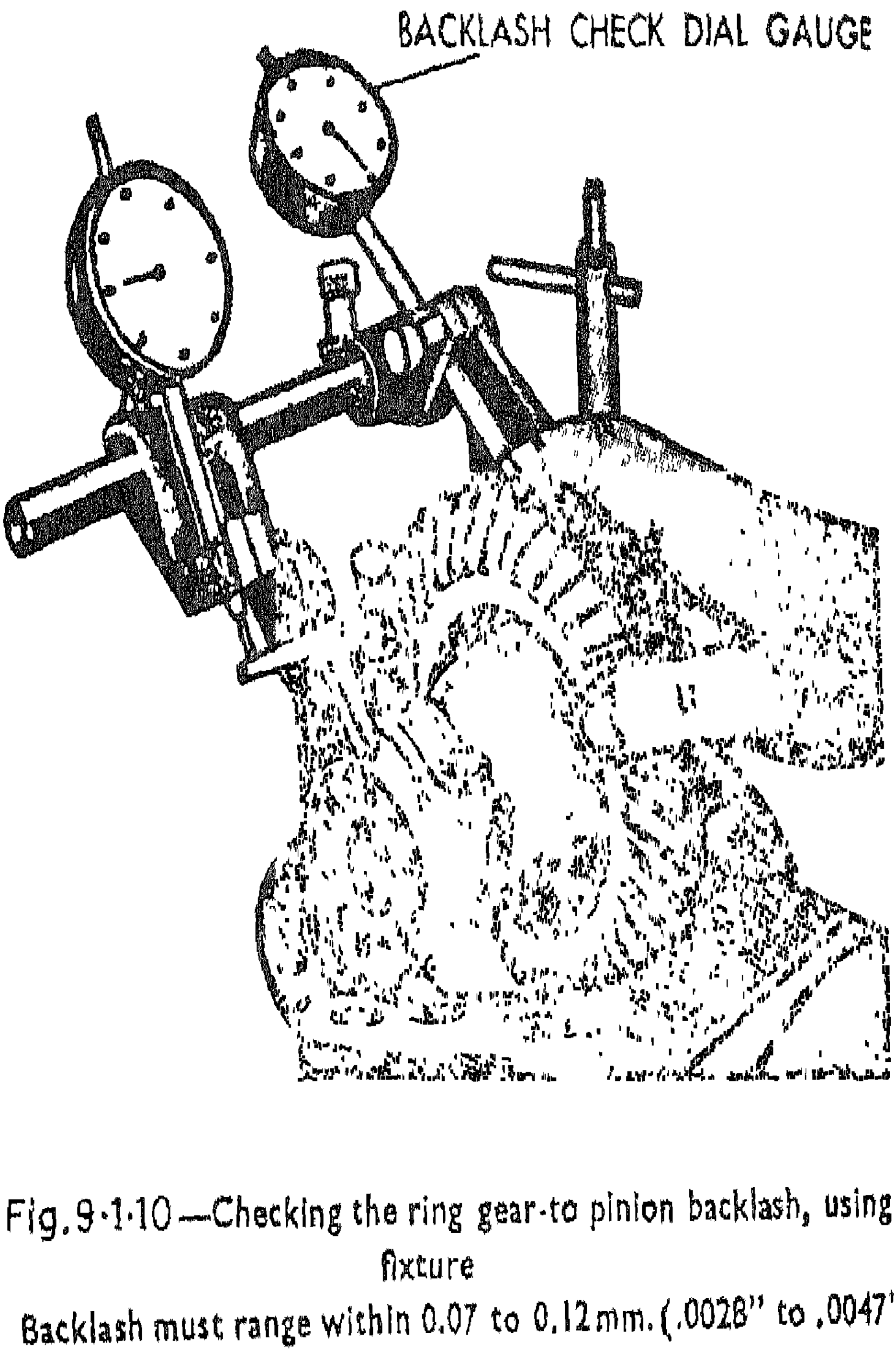
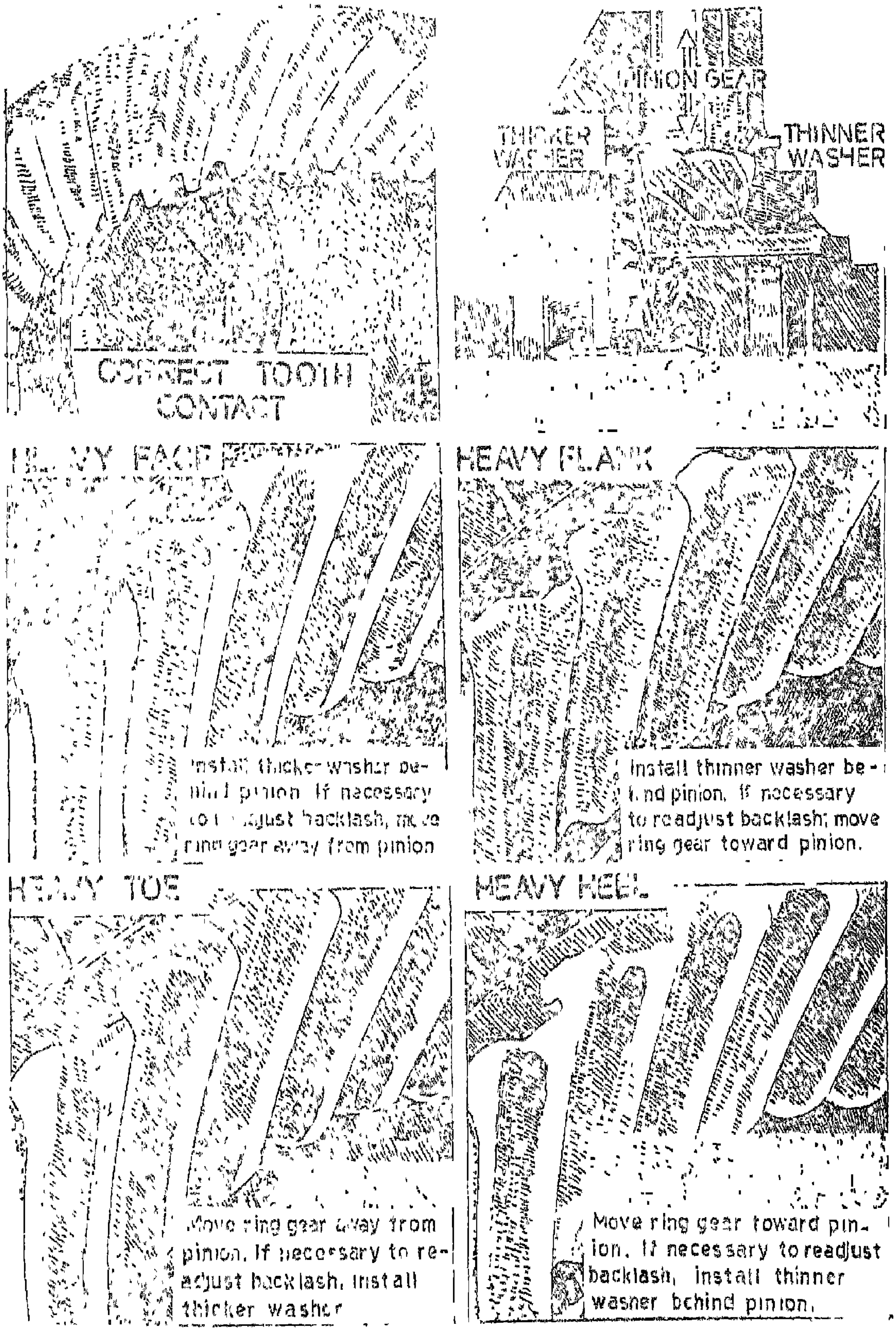


Fig. 9·1·10—Checking the ring gear-to pinion backlash, using fixture

Backlash must range within 0.07 to 0.12 mm. (.0028" to .0047").



Install thicker washer behind pinion. If necessary to readjust backlash, move ring gear away from pinion

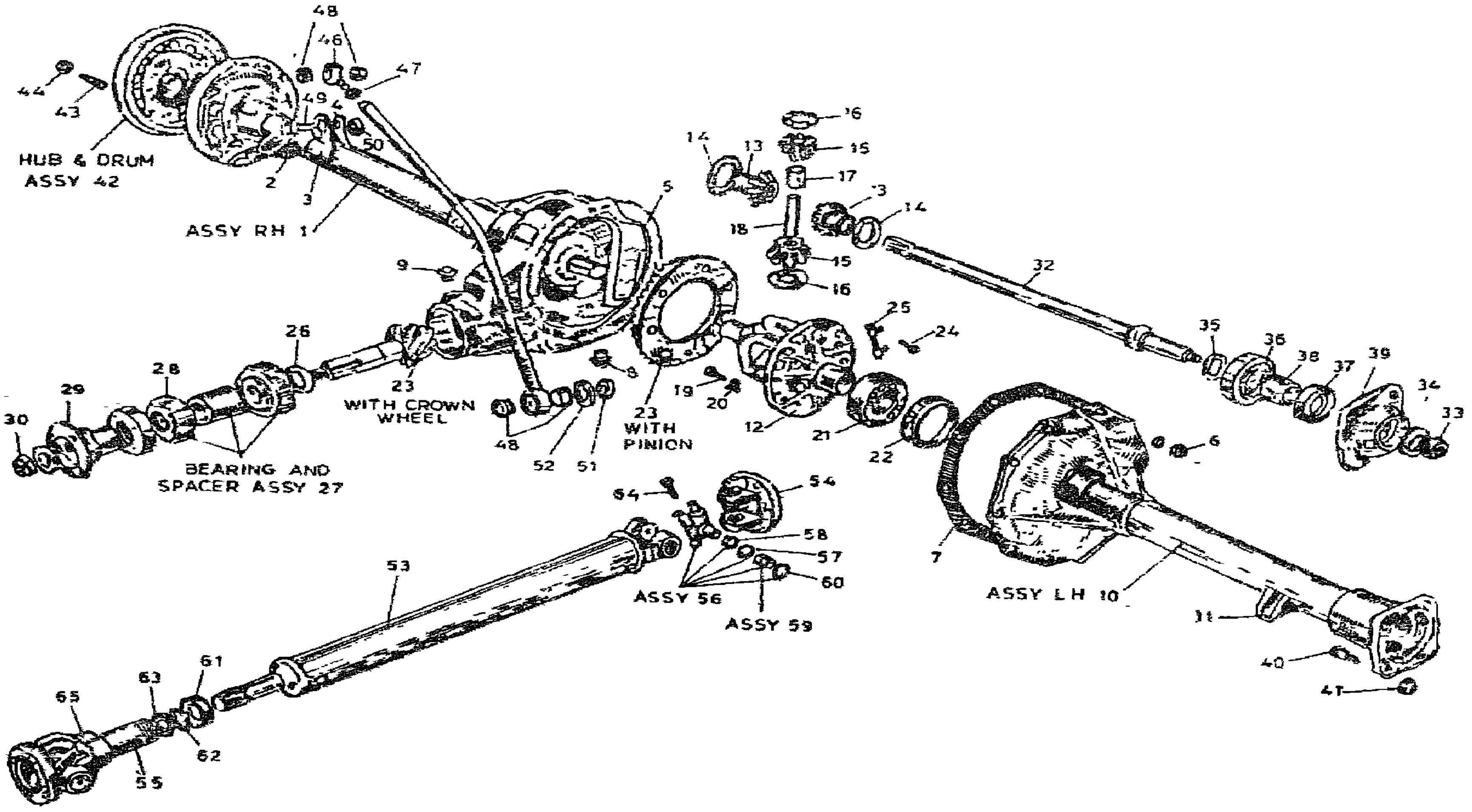
Install thinner washer behind pinion. If necessary to readjust backlash, move ring gear toward pinion.

Move ring gear away from pinion. If necessary to readjust backlash, install thicker washer

Move ring gear toward pinion. If necessary to readjust backlash, install thinner washer behind pinion.

FIG 10-9.111. RING GEAR TOOTH CONTACT PATTERNS

FIG. – 9-1-12-THE REAR AXLE COMPONENTS



KEY TO THE REAR AXLE AND PROPELLER SHAFT COMPONENTS

No.	Description	No.	Description	No.	Description
1.	Axle tube and casing assembly R/H	23.	Crown wheel and pinion	45.	Sway bar Not actually provided.
2.	Rear spring seat	24.	Bolt—crown wheel to cage.	46.	Eye—sway bar.
3.	Bracket—sway bar—front	25.	Locking tab—bolt.	47.	Locknut—eye
4.	Bracket—sway bar—rear	26.	Distance-piece—pinion rear bearing	48.	Bush—rubber—sway bar
5.	Stud—cover.	27.	Bearing spacer assembly	49.	Pin—eye to axle bracket
6.	Nut—axle cover stud.	28.	Oil seal—pinion—front	50.	Nut—eye pin.
7.	Joint—casing to cover	29.	Flange—universal joint	51.	Nut—bar to frame
8.	Drain plug.	30.	Nut—pinion—castle.	52.	Washer—nut.
9.	Filler plug.	31.	Washer—castle nut.	53.	Tubular shaft.
10.	Axle tube and cover assembly—L/H.	32.	Axle shaft.	54.	Flange yoke
11.	Rear spring seat.	33.	Nut—axle shaft	55.	Sleeve yoke.
12.	Cage—differential	34.	Washer—axle shaft nut.	56.	Journal and needle kit set
13.	Gear—differential.	35.	Distance washer—hub bearing.	57.	Gasket—journal.
14.	Washer—differential gear.	36.	Bearing—hub.	58.	Retainer—journal gasket.
15.	Pinion—differential.	37.	Oil seal—hub.	59.	Bearing assembly—needle
16.	Washer—differential pinion.	38.	Collar—oil seal.	60.	Snap ring.
17.	Distance-piece—pinion.	39.	Support—brake plate.	61.	Dust cap.
18.	Pin—pinion.	40.	Bolt—plate support	62.	Steel washer.
19.	Bolt—pinion pin lock.	41.	Nut—support bolt	63.	Cork washer
20.	Tab washer—pin lock bolt.	42.	Hub and brake-drum	64.	Grease nipple—journal
21.	Bearing—differential.	43.	Wheel stud.	65.	Grease nipple—stub shaft.
22.	Distance collar—bearing	44.	Nut—wheel stud		

NOTE.—Models fitted with telescopic dampers are not fitted with the sway bar parts 45 to 52 inclusive, as the damper mounting provides the necessary anti-sway control.

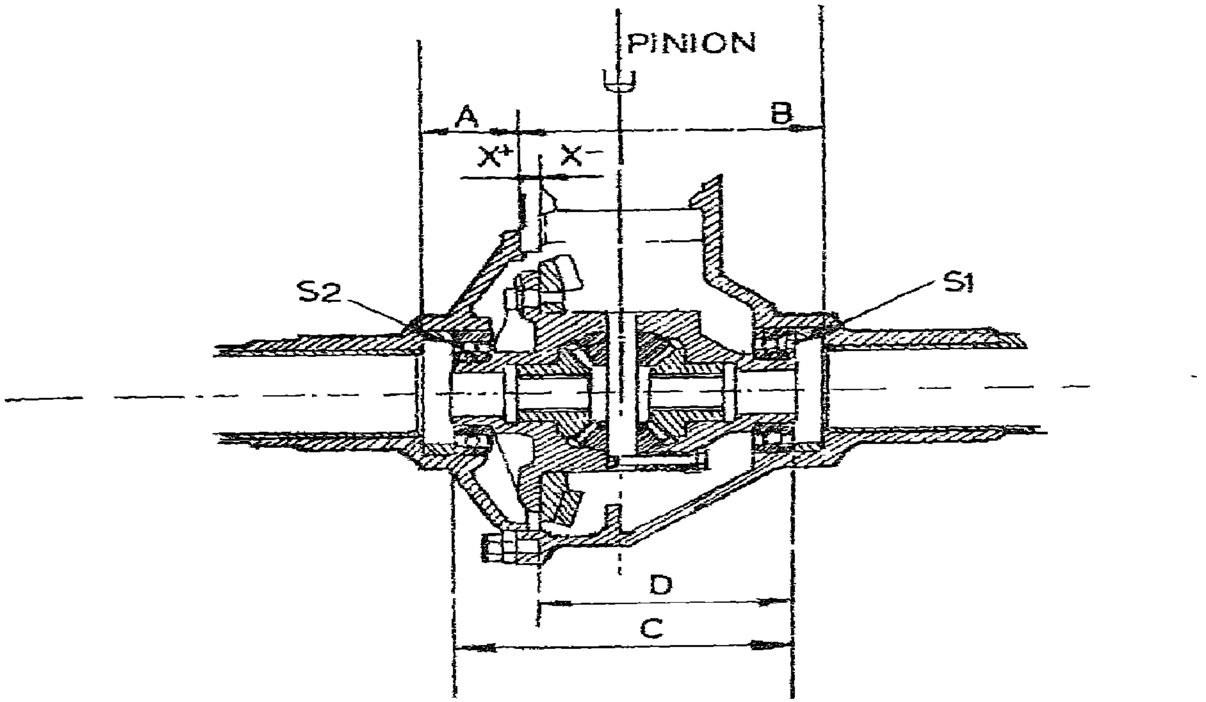


FIG NO-9.1.13 THIS DIAGRAM INDICATES THE SIGNIFICANCE OF THE "A", "B", "C", "D". DIMENSIONS.

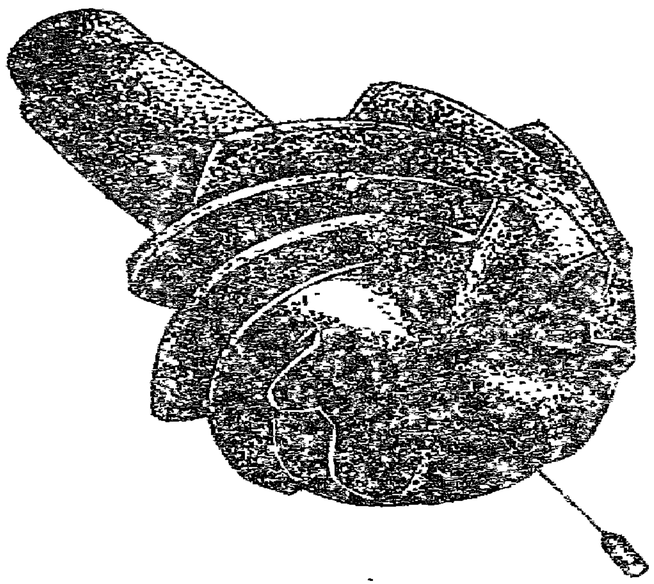


FIG 9-1-14

THE MARKING OF THE PINION TO SHOW ITS DIMENSION FOR FITTING IS INDICATED BY THE ARROW

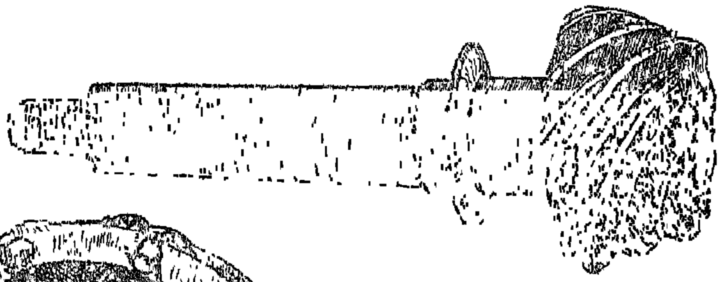


FIG 9.1.15 (a) The pinion and pinion spacing washer. Note that the bevelled side of the washer bore should be against the pinion

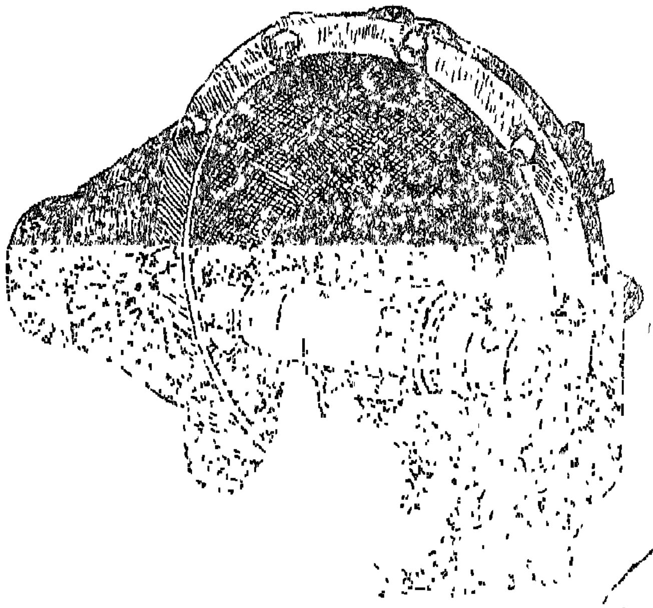


FIG 9.1.15 (b)

Inserting the special dummy pinion shaft into the axle casing pinion housing

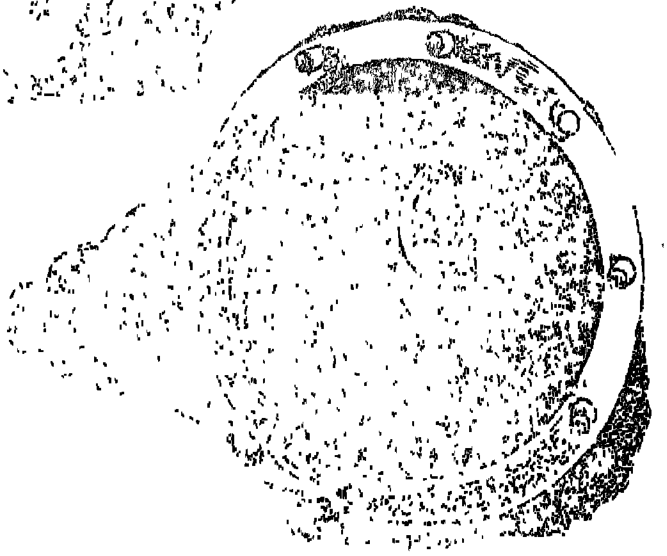


FIG. 9.1.15 (c)

The dummy pinion shaft in position in the housing. The ground head of the dummy shaft forms the datum for establishing the correct thickness for the spacing washer.

FIG. 9.1.15

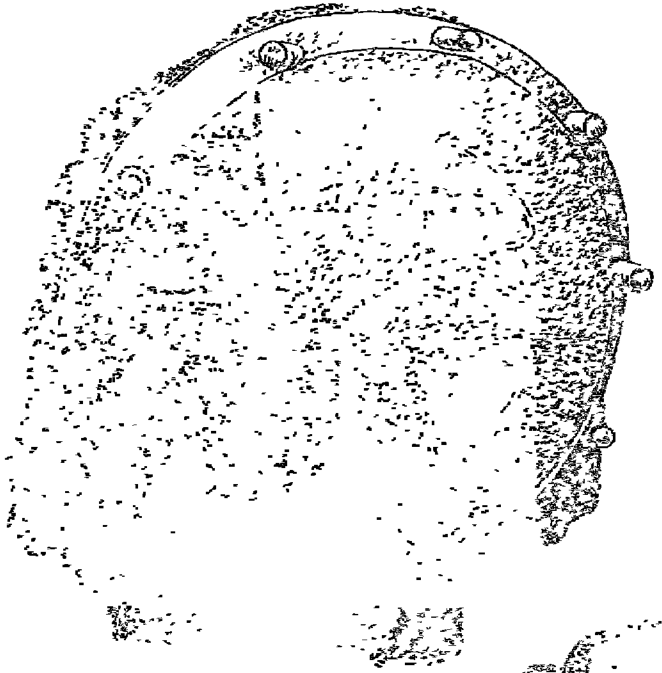


FIG 9-1-16
(Above) WHEN THE LOCATING TONGUE OF THE SPECIAL CHECKING FIXTURE IS IN CONTACT WITH THE HEAD OF THE DUMMY PINION SPINDLE THE SPACE BETWEEN THE HEAD OF THE SPINDLE AND THE ANVIL OF THE CHECKING FIXTURE DETERMINES THE THICKNESS OF THE PINION SPACING WASHER

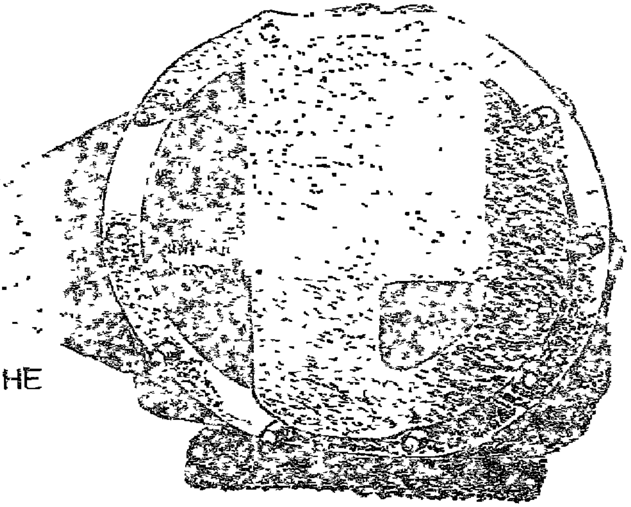


FIG 9.1.17
(Right) THE SPECIAL CHECKING FIXTURE FOR DETERMINING THE CORRECT SPECING WASHER THICKNESS IN POSITION IN THE AXLE CAING NOTE THAT ITS LOCATING TONGUE IS MAKING CONTACT WITH THE HEAD OF THE DUMMY PINION SPINDLE.

Experiment No. 10.1.7

General Objective : To study the components of a braking system for 4 wheeler (Car).

Specific Objective :

To dismantle and reassemble the braking system of a four wheeler (Car).

Introduction

Brakes are provided in the automobile to stop it or to reduce its speed whenever desired. The vehicle can stop without using brakes but the stopping distance will be more. Brakes also serve the purpose of holding the vehicle when it has been parked. Four wheelers are provided with service brakes and emergency (parking) brakes. Service brakes are operated hydraulically whereas emergency brakes are mechanically operated. In some Ambassador cars, hydraulic pressure is assisted by a vacuum operated booster, whereas in the Fiat and Jeep it is by pedal effort only. In four wheelers, mechanical brakes are operated by a hand lever. The utility of the different braking systems depend on the requirement of the mechanical advantage in the vehicle because pedal force which is exerted by the driver is limited. Hydraulic brakes have more mechanical advantage as compared to mechanical brakes. Similarly vacuum brakes and air brakes, which are used in buses and trucks, have more mechanical advantage as compared to hydraulic brakes.

Equipments

1. Four wheeler (Car or jeep)
2. Pressure Bleeder

Tools

1. Jack
2. Stands
3. Spanner set
4. Plier
5. Screw drivers
6. Drum puller
7. Bleeding tube
8. Special tools

Procedure

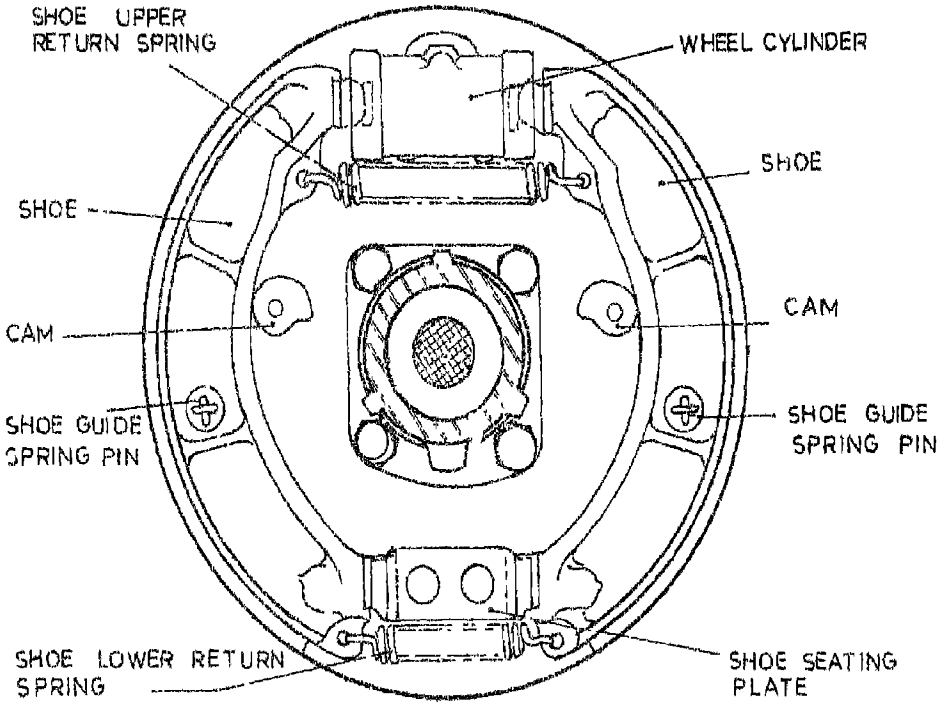
Figure 10.1.1 shows different parts of the front and rear wheel brake housing complete with shoes.

Figure 10.1.2 gives an exploded view of a wheel cylinder.

Figure 10.1.3 gives a sectional view of a master cylinder.

Figure 10.1.4 gives a layout diagram of the hand brake and Hydraulic Pipe connections.

FIG NO-10.1.1. BRAKES FRONT



BRAKES REAR.

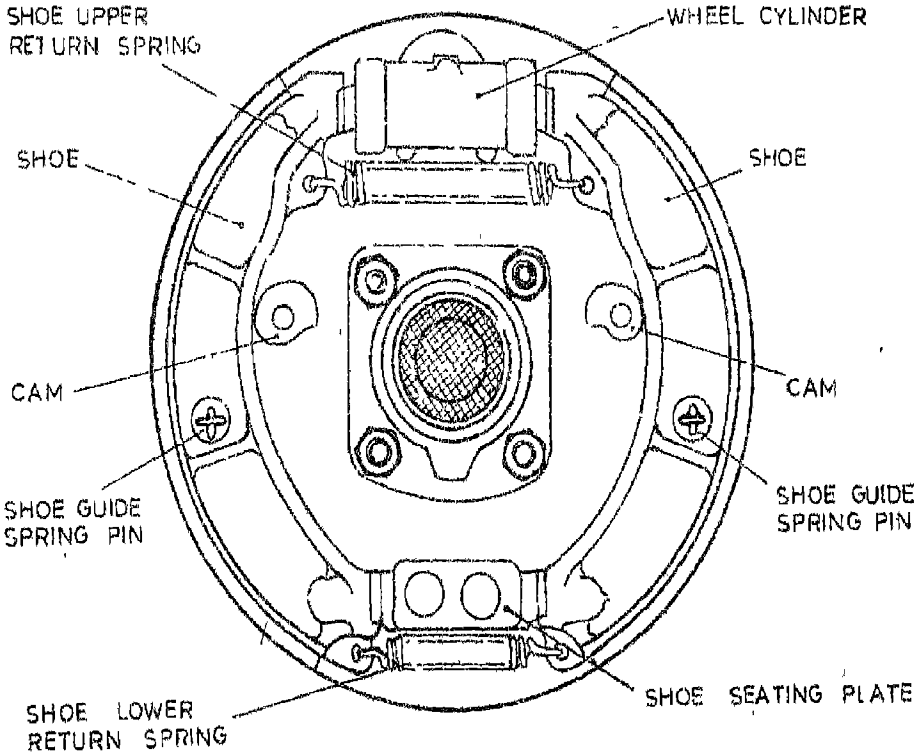
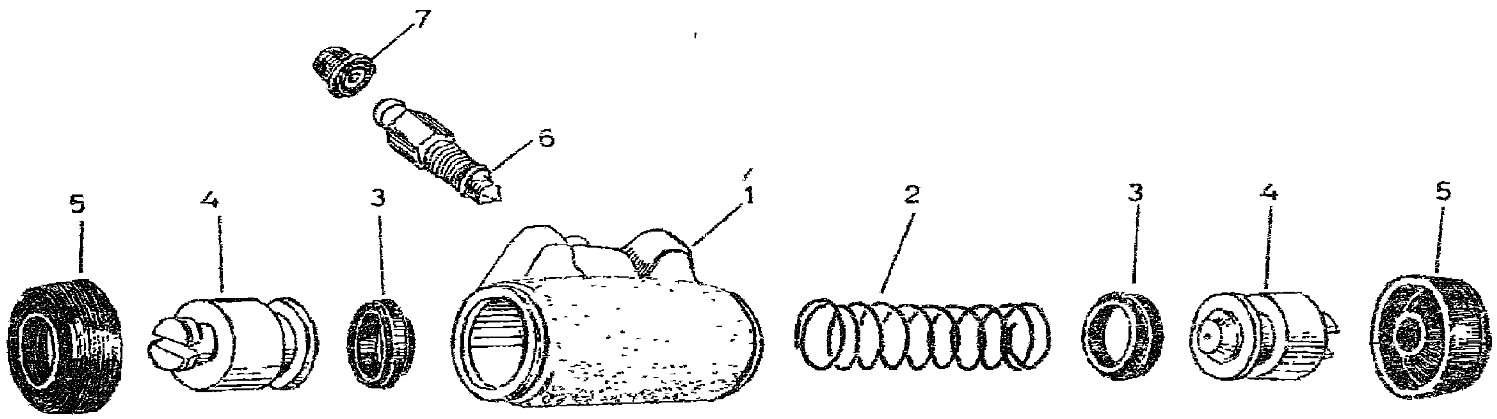


FIG NO -10.1.2 WHEEL CYLINDER EXPLODED VIEW



1 WHEEL CYLINDER BODY
2 SPRING
3 GLAND SEAL
4 PISTON
5 DUST COVER
6 BLEED SCREW.
7 DUST COVER.

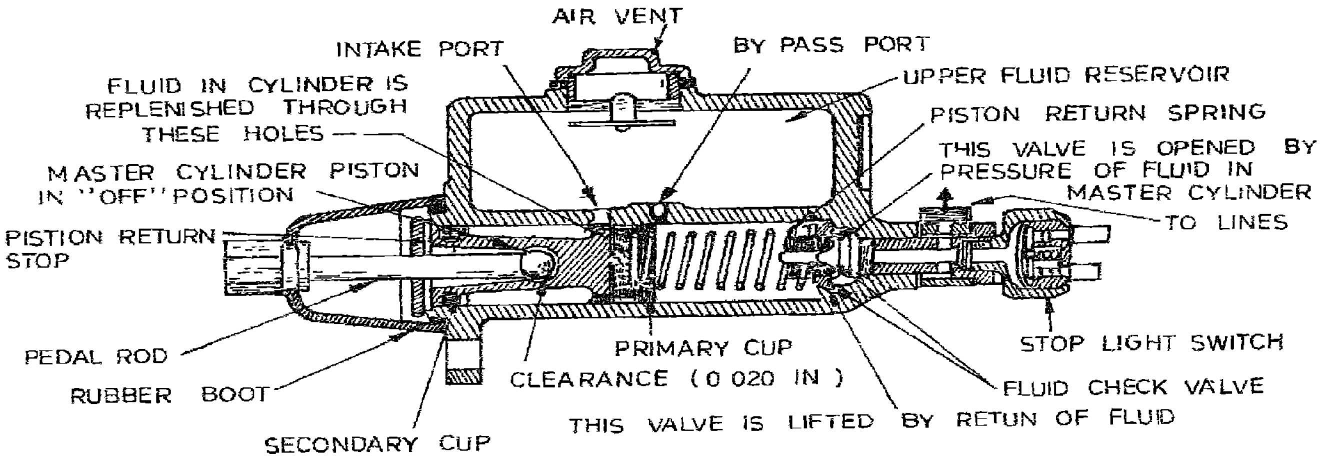
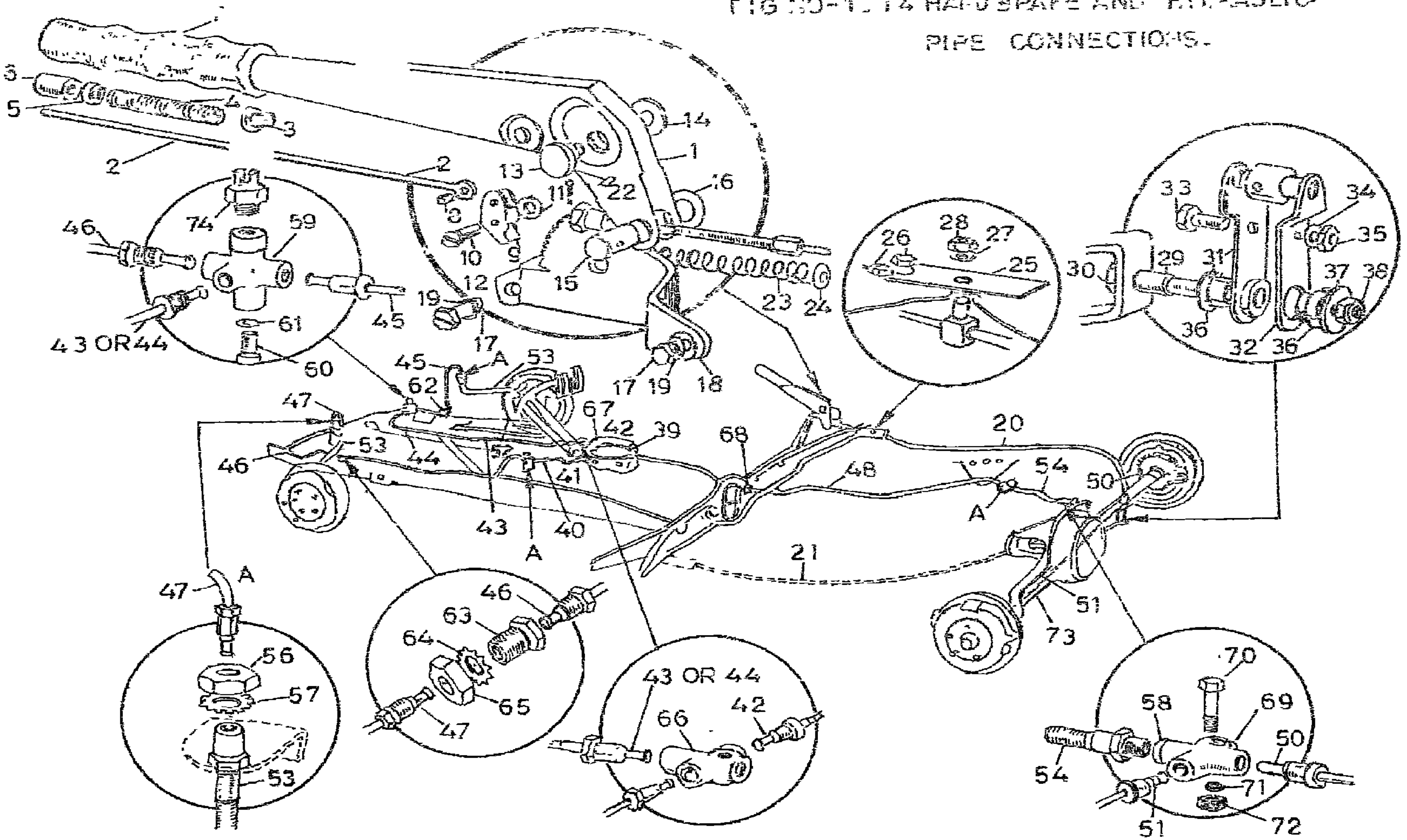


FIG NO-10.1.3. MASTER CYLINDER

FIG NO-TB 14 HAND BRAKE AND HYDRAULIC PIPE CONNECTIONS.



KEY TO HAND BRAKE AND HYDRAULIC PIPE CONNECTIONS

Legend of Fig. 10.1.4

1. Lever hand brake
2. Rod-Pawl.
3. Bush-Pawl rod guide
4. Spring-pawl return
5. Washer-pawl rod knob
6. Knob-pawl rod.
7. Grip-brake lever
8. Pin rod to pawl.
9. Pawl.
10. Pin-pawl fulcrum.
11. Washer-anti-rattle-pin
12. Ratchet.
13. pin-pivot.
14. Washer-pivot pin.
15. Pin-to cable.
16 Washer-pin.
17. Screw-ratchet to body
18. Washer-screw
19. Washer-spring screw
20. Cable.
21. Canle (LHD)
22. Nut-adjusting.
23. Spring-cable.
24. Washer-cable spring.
25. Fairlead.
26. Screw fairlead to floor.
27. Washer-spring-abutment to floor.
28. Nut-abutment to floor.
29. Pivot-compensator.
30. Nut-pivot.
31. Lever assembly-front compensating.
32. Lever-rear compensating.
33. Screw-Lever clamping.
34. Washer-spring-screw.
35. Nut-screw
36. Bush-lever pivot.
37. Washer-lever pivot
38. Nut-Lever-Pivot
39. Pipe-master cylinder to frame adaptor-clutch
40. Pipe-frame adaptor to hose bracket-clutch.
41. Pipe-Frame adamtor to hose bracket-clutch(LHD)
42. pipe-master clyinder to three way connector-brake.
43. Pipe-three-way connector to stop-light swttch connector.
44. Pipe-three-way connector to stop-light switch connector(LHD)
45. Pipe-stop light connector R/h front hose bracket
46. Pipe-stoplight connector to L/H frame adaptor.
47. Pipe-L/H frame adaptor to front hose bracket.
48. Pipe-front three-way to rear hose bracket.
49. Pipe-front three way to rear hose bracket (LHD)
50. Pipe-rear axle three way to R/H wheel.
51. Pipe-rear axle three-way to L/H whee.
52. Pipe-front wheel cylinder bridge.
53. Hose-front brake.
54. Hose-rear brake.
55. Hose-clutch
56. Locknut hose.
57. Washer-shakeproof.
58. Gasket small brake hose.
59. Coonector-stop light switch
60. Scre-connector to frame.
61. Wssher spring screw.
62. Grommet front valance.
63. Coonector brake through valance - L/H.
64 Washer- shakerproof connector.
65. Locknut-connector.
66. Connector-three way brake-through frame front.
67. Gromment-connector.
68. Grommet-through cross-member.
69. Connector-three way brake rear.
70 Screw connector to rear axle.
71. Washer-spring-screw.
72. Nut-screw.
73. Strap-pipes to rear axle.
74. Switon-stop-lamp.

Observation sheet

[illegible] housing with shoes

S.No.	Components	Material	Purpose	Remarks

Wheel Cylinder

S.No.	Component	Material	Purpose	Remarks

Master Cylinder

S.No.	Component	Material	Purpose	Remarks

Handbrake and Hydraulic Pipe Layout

S.No.	Component	Material	Purpose	Remarks

Experiment No. 10.1.2

To Dismantle, Inspect, and reassemble the Brake Housing complete, and wheel cylinder.

Procedure

1. Put vehicle on the stands with the help of jacks and take out wheels.
2. Take out wheel cup and grease cap.
3. Take out split pin and open the nut.
4. Take out brake drums. Use puller for taking out rear brake drums, if necessary.
5. Dismantle brake shoes, remove wheel cylinders and disconnect hand brake cables. Plug the hydraulic pipe line.
6. Clean and wash all the parts. Use petrol for washing the brake lining and kerosene oil for washing other parts. Finally wash brake drums in petrol and brake rubber parts in spirit or brake fluid.
7. Dismantle the wheel cylinder and disassemble it.
8. Clean and wash all the parts.

Inspection and Repair

1. Check lining for wear, tear or oiling. Replace if necessary. If the lining is bonded, replace the shoe. If the lining is riveted, drill out the rivets and replace the lining on .

the shoe [illegible] and fixing the lining,

2. Check the drum [illegible] scratching or bad [illegible] turn it on drum turning lathe machine.
3. Check front wheel bearing of the front wheel. If worn-out, replace.
4. Check oil seal and replace them, if necessary.
5. Check flexible pipe line or metallic pipe line for any possible leakage.
6. Check wheel cylinder bore for wear. If worn out, replace.
7. Check wheel cylinder piston for wear. If worn out, replace.

Assembly

1. Fit in the wheel cylinder.
2. Fit shoe with return springs & mount it on the plate.
3. Fit drum on the axle and tighten the nut fully on the near wheel and a recommended preload on the front axle bearing.
4. Adjust the brake shoe.
5. Connect tubes
6. Fill brake fluid in the resorvior after bleeding the air at each wheel and fit the seal in the master cylinder.

[illegible]

[illegible]

7. Fit [illegible]

8. [illegible] using jacks.

[illegible]

To Dismantle, Disassemble Inspect and reassemble and re-fit the Master Cylinder of a 4 wheeler (Car).

Dismantling and Disassembly

1. Put the vehicle on the stands with the help of the jacks.
2. Remove the Master Cylinder. Plug the hydraulic pipe or alternatively drain out the hydraulic fluid completely.
3. Dismantle the master cylinder after removing the seal pipe line, bolts and disconnecting pedal linkage.
4. Remove the lock, open the screws and remove the plate in some Fiat Cars if they are provoded.
5. Take out all the parts from the body.
6. Clean and wash all the parts of the master cylinder in sprit.

Inspection and Repairs

1. Check master cylinder bore for wear. If worn out replace.

2. Check master cylinder piston for wear. If worn out replace. The desirable clearance between cylinder and piston is 0.003 in. to 0.0065 in.

Reassembly and Refitting

1. Reassemble the master cylinder by putting the seal, valve, spring, cupseal, piston assembly, plain washer, circlip, dustcover, and push rod.
2. Mount it on the foundation in the vehicle and connect the linkage.
3. Connect the hydraulic pipe connections.
4. Fill the master cylinder with the brake fluid recommended by the manufacturer.
5. Perform the bleeding test on the hydraulic pipe lines to remove the air pockets in them.
6. Take out the stands and jacks.
7. Test run the vehicle and rebleed if necessary.

Trouble Shooting (4 wheelers)

Trouble	Possible causes	Remedies
A. LONG PEDAL TRAVEL OR PEDAL GOES UPTO FLOOR BOARD	a. Excessive clearance between linings and drum	a. Adjust brakes.
	b. Weak hose	b. Replace with new hose.
	c. Leaking wheel cylinder	c. Service with wheel cylinder repair kit.
	d. Leaking master cylinder	d. Service with master cylinder repair kit.
	e. Leaking stop light switch	e. Replace with stop light switch
	f. Air in system	f. Bleed the system.
	g. Blocked master cylinder filler cap vent hole	g. Clean vent hole or replace cap.
	h. Low fluid level in master cylinder.	h. Fill the reservoir with brake fluid and bleed the system.
	i. Wear of brake pedal bush	i. Replace the bush.

Trouble.	Possible causes	Remedies
B. SPRINGY, SPONGY PEDAL	a. Air trapped in hydraulic system	a. Bleed the system.
	b. Badly lined shoes excessive gap between lining and shoe	b. Reline the shoes properly
	c. Shoes distorted	c. Replace the shoes.
	d. Bell mouthed, worn out, weak or cracked drums	d. Replace drums.
	e. Master cylinder fillter cap vent clogged	e. Clean vent hole or replace cap bleed system.
	f. Weak hose	f. Replace with new hose.
	g. Weak master cylinder mounting (yielding)	g. Check and strengthen master cylinder mounting.
	h. Bent master cylinder push rod and clevis.	h. Repair push rod and clevis.
	i. Unbedded linings	i. Bed linings.
C. BRAKES PULLING (VEHICLE PULLS TO ONE SIDE)	a. Uneven adjustment of brakes.	a. Adjust all the brakes evenly.
	b. Tyres improperly inflated	b. Inflate to recommended pressure.
	c. Tyre tread unevenly worn on either side or different type of treads	c. Replace with same type of treads all round.

Trouble	Possible causes	Remedies
	d. Grease or fluid soaked lining on the brake opposite to the direction of pulling.	d. Replace linings and rectify [illegible] cause of grease or fluid leak.
	e. Linings of different grades on either side of brakes	Replace with recommended grade of linings all round.
	f. Unbedded lining	f. Bed linings.
	g. Shoes wrongly fitted	g. Install leading and trailing shoes correctly.
	h. Rivets loose in lining	h. Rivet properly.
	i. Wheel cylinder piston seized	i. Service or replace wheel cylinder.
	j. Wheel cylinder diameter different on opposite side	j. Replace with correct cylinder.
	k. Clogged or restriction in hydraulic hose or bundy pipe	k. Clean or replace pipe lines.
	l. Weak or broken shoe return springs.	l. Check and replace weak open coiled or cracked springs.
	m. Drums oval or eccentric	m. True up or replace
	n. Loose back plate mounting bolts loose shoe abutment or adjuster housing.	n. Tighten back plate mounting bolts and adjuster housing mountings. If abutment is loose, replace back plate.
	o. Improper steering geometry	o. Reset according to specification.
	p. Loose or worn tie-rod ends	p. Tighten or replace.

Trouble	Possible causes	Remedies
	q. Loose king pin and bushes	q. Replace pins and bushes
	r. Loose wheel bearings, loose steering, loose U. Clamp nuts.	r. Adjust wheel bearings. adjust steering and tighten 'U' clamp nuts.
	s. Weak shock absorbers	s. Replace.
D. FADE(FADE IS A TEMPORARY REDUCTION OF BRAKE EFFECTIVENESS RESULTING FROM HEAT)	a. Incorrect grade of lining	a. Replace with recommended grade of lining.
	b. Distorted shoes	b. Replace shoes
	c. Over loaded vehicle	c. Load the vehicle to the recommended GVW.
	d. Dragging brakes	d. Adjust or correct the cause.
	e. Thin drums	e. Replace drums
	f. Old hydraulic fluid	f. Replace with new fluid.
E. HARD PEDAL, POOR BRAKING	a. Incorrect brake adjustment	a. Adjust the brakes
	b. Incorrect lining	b. Replace with recommended lining.
	c. Grease or fluid soaked lining	c. Remedy the cause for grease or fluid leak and replace lining

Trouble	Possible causes	Remedies
	d. Unbedded linings (lining not in full contact)	d. Bed the linings.
	e. Glazed linings.	e. Sandpaper the lining surface.
	f. Brake pedal binding on shaft	f. Lubricate or recondition pedal bushes.
	g. Seized master cylinder or wheel cylinder piston	g. Service master cylinder or wheel cylinder.
	h. Shoes wrongly fitted	h. Install leading and trailing shoes correctly.
	i. Bell mouthed barrel shaped or polished drums.	i. Replace or skin drums as necessary.
F. BRAKE PEDAL TRAVEL DECREASING	a. Master cylinder recuperating hole blocked	a. Service master cylinder
	b. Swollen cup seal in master cylinder.	b. Flush the system. Replace all rubber parts.
	c. Weak shoe retracting springs.	c. Replace springs.
	d. Wheel cylinder piston sticky	d. Service wheel cylinder and replace internal parts.
	e. Linings swelling	e. Fit recommended replacement linings.

Trouble	Possible causes	Remedies
G. JUDDER IN BRAKE PEDAL	a. Excessive ovality in drums	a. True up drums.
	b. Loose brake drum on hub	b. Tighten
	c. Worn or loose bearing	c. Replace or adjust
	d. Rusty drums	d. De-rust drums or replace
H. BRAKES BINDING	a. Pedal does not return fully	a. Lubricate pedal shaft or re-condition pedal shaft and bushes.
	b. No clearance between push rod and master cylinder piston	b. Adjust brake pedal free play
	c. Maladjusted brakes or hand brake	c. Check and adjust brakes and hand brake linkage.
	d. Recuperating and feed port clogged in master cylinder	d. Remove master cylinder and service.
	e. Seals swollen	e. Flush system and replace all rubber parts
	f. Seized wheel cylinder piston	f. Service or replace wheel cylinder
	g. Improper brake fluid	g. Replace with heavy duty brake fluid to SAE J 1703
	h. Shoe return springs weak or broken.	h. Replace springs.

Trouble	Possible causes	Remedy
	i. Filler cap vent hole blocked	Clean vent hole or replace cap
I. ONE WHEEL DRAGS	a. Weak or broken shoe retracting springs.	a. Replace springs.
	b. Brake shoe to drum clearance too small on one side	b. Adjust brakes
	c. Loose wheel bearings	c. Adjust wheel bearings.
	d. Wheel cylinder piston cup seals swollen or piston seized	d. Service wheel cylinder
	e. Excessive ovality in drum	e. True up drums.
	f. Obstruction in hydraulic line	f. Flush lines
	g. Distorted shoes	g. Replace shoes
	h. Incorrect grade of lining	h. Replace with recommended lining.
J. REAR BRAKE DRAGS	a. Maladjustment	a. Adjust brake shoes and parking brake mechanism
	b. Parking brake cable seized	b. Lubricate and adjust cables.

Trouble	Possible causes	Remedies
K. BRAKE SQUEAL	a. Back-plate bent or shoe slightly twisted	a. Replace parts.
	b. Metallic parts or dust embedded in lining	b. Sandpaper the linings and drums and remove metal particles if any or replace lining and drum if necessary.
	c. Loose rivets or lining not held evently against shoe rim (gap between lining and shoe rim)	c. Reline shoes properly.
	d. Drums not true, weak or distroted	d. True up or replace drums.
	e. Incorrect grade of lining	e. Replace lining with recommended linings.
	f. Shoes scraping on back-plate shoe pads	f. Lubricate shoe pads with high melting point graphite grease
	g. Weak or broken hold down springs.	g. Replace defective parts.
	h. Loose wheel bearing	h. Adjust bearings.
	i. Loose backplate or wheel cylinder or drum	i. Tighten
	j. Over adjusted steady post	j. Adjust properly.
	k. Glazed lining	k. Surface linings with sandpaper.
	l. Highly polished drum	l. Skin drum.

Trouble	Possible causes	Remedies
L. SNAPPING NOISE IN FRONT END	a. Deep grooves in back plate shoe pads.	a. Replace backplate
	b. Lack of lubrication on moving parts.	b. Lubricate all moving parts on backplate with high melting point graphite grease.
	c. Loose drums or backplate	c. Tighten.
	d. Loose or worn front end parts.	d. Tighten or replace defective parts.
M. THUMPING NOISE WHEN BRAKES ARE APPLIED	a. Loose backplate drums or axle 'U' bolts	a. Tighten
	b. Grabbing linings	b. Replace with recommended grade of linings.
	c. Shoe retracting springs unequal - weak	c. Replace springs.
N. GRINDING NOISE	a. Shoe rim fouling with the drum	a. Check shoe retracting springs for correct fitment.
	b. Weak shoe hold down springs or bent pin	b. Replace parts
	c. Bent shoe web	c. Replace shoe
	d. Foreign material in lining	d. Remove or replace lining.

Trouble	Possible causes	Remedies
	e. Worn out or broken lining	e. Replace with relining kit skin or replace drum if scored.
	f. Rough drum surface	f. Skin drums.
	g. Improper adjustment of steady post.	g. Adjust properly.

Review Questions (Four Wheeler)

1. What is bleeding of the braking system? Explain the process.

2. What are the reasons for "spongy brake?

3. Describe the main parts of the Hydraulic brake system?

4.(a) What happens if the master cylinder reservoir runs dry?

(b) How would you rectify the situation caused by (a) above?

5. Strike the wrong statement given below:-

(i) In trucks, the system of wheel braking employed is mechanical/Hydraulic/pneumatic.

(ii) In scooters the bleeding of brakes is necessary/not necessary.

(iii) In jeeps we use mechanical/Hydraulic/air brakes.

(iv) The function of master cylinder is to increase/decrease pressure equally/ unequally in all wheels cylinders.

(v) The brake pipes in hydranlic brakes are made of a rubber/ steel/ copper.

6. Why are parking brakes always separate from the regular braking system ?

7. What is the great advantage of hydraulic brakes ?

Experiment No. 10.2.1

General Objective: To study the compenents of a braking system for a 2 wheeler (Scooter and Motor Cycle)

Specific Objective:

To disassemble, Inspect and Reassemble the braking system of a two-wheeler.

Introduction

Brakes are provided in the scooter to stop it or to reduce its speed whenever desired. The vehicle can stop without using brakes but the stopping distance will be more.

Two wheelers are provided with mechanical brakes. The brake on the rear wheel is operated by a foot pedal while the brake on the front wheel is

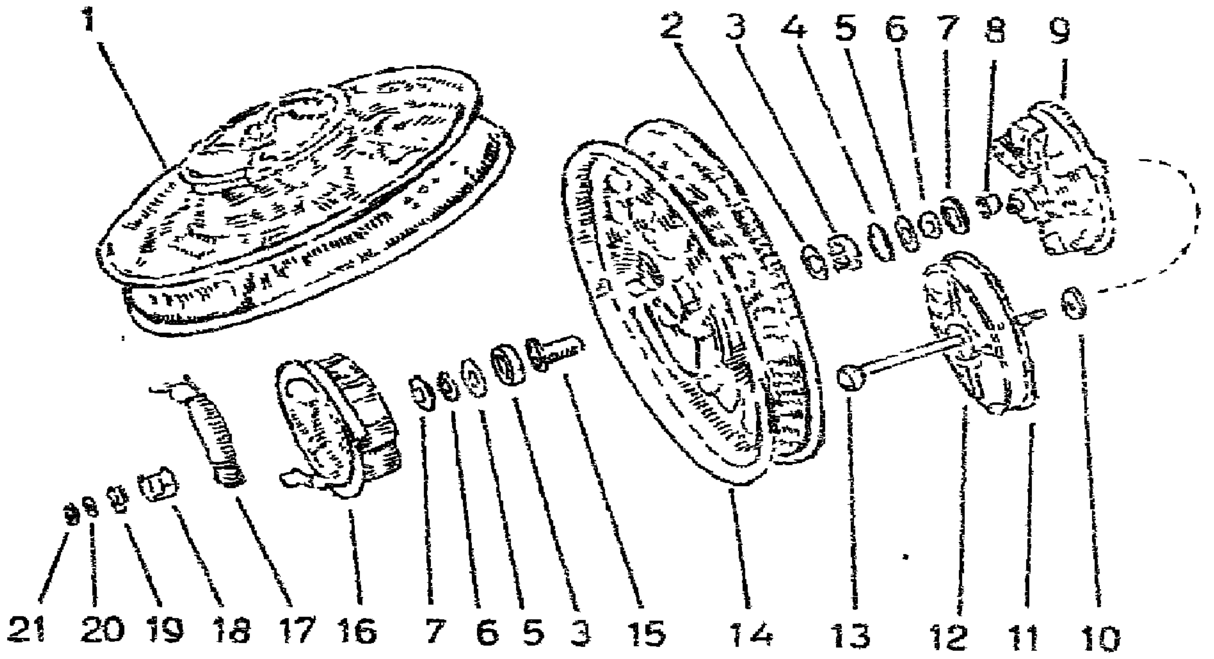
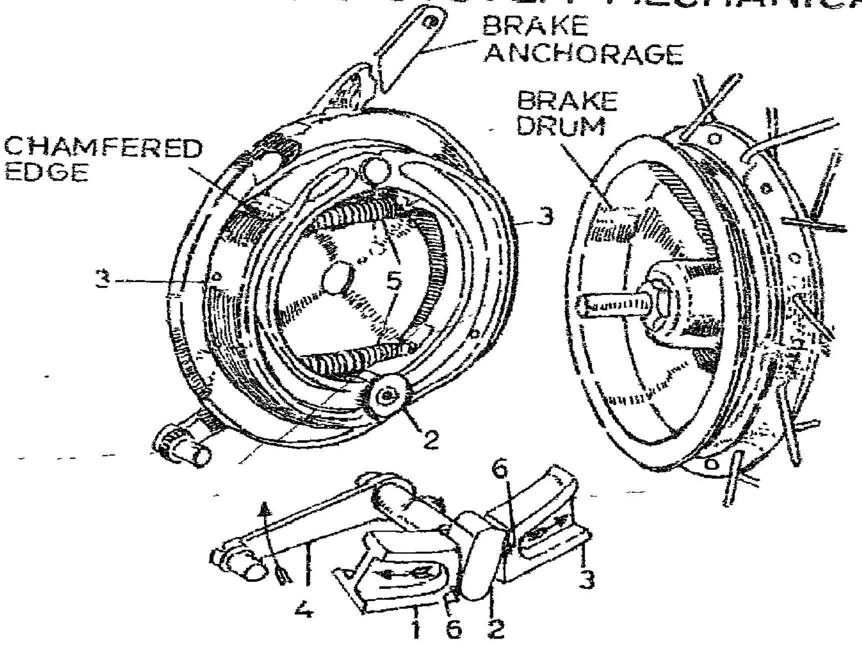


FIG : 10.2.1.1
REAR WHEEL EXPLODED VIEW-OF MOTOR CYCLE.

ITEM NO	DESCRIPTION OF PARTS.
16	BACK PLATE OF BRAKE ASSEMBLY.
1,14.	RIM
2	WASHER
3	BEARING
4	SPRING LOCK RING
5	WASHER
6	DISTANCE PIECE
7	WASHER.
8	SPACER.
9	SPROCKET WHEEL
10	NUT FOR AXLE SHAFT
11,12	DUST COVER.
13	AXLE BOLT
15	DISTANCE TUBE
17	BRAKE BACK PLATE
18	LOCK PLATE FOR BACK PLATE
19, 21	WASHER.
20	SPACER.

FIG NO -10.2.1.2 BRAKE SYSTEM MECHANICAL



1) BRAKE SHOE
2 CAM.
3 BRAKE SHOE

4 BRAKE LEVER
5 BRAKE SHOE RETURN SPRING
6 WEARING SURFACE.

operated by a hand lever.

The rear wheel brake is a service brake whereas the front wheel brake is used in an emergency when the speed of the vehicle is low.

Equipment

1. Two wheeler (Scooter or Motor Cycle)

Tools

1. Tack
2. Screw Driver
3. Double ended spanner set.
4. Adjustable screw spanner.
5. Hammer

Procedure

Figure 10.2.1.1 shows the rear wheel brake drum - exploded view- of a motor cycle (Yezdi D - 250 classic)

Figure 10.2.1.2. shows the components of a typical mechanical brake system.

Observation Sheet

Mechanical Brake system

S.No.	Component	Material	Purpose	Remarks

Experiment No. 10.2.2.

Disassembly and assembly of the braking system of a two wheeler

Disassembly

1. Park the vehicle in proper position (see figs 10.2.2.1 and 10.2.2.2.)
2. Release the rear brake cable. Unscrew the spindle nut.
3. Remove the spring washer and pull out the spindle to the right hand side.
4. Remove the brake reaction bracket on the left hand side.
5. Slide off the wheel of the rubber blocks (coupling of the chair wheel) and inclining the motor cycle to one side remove the wheel.
6. Clean and wash all the parts in cleaning solvent except brake shoes.

Assembly

1. To assemble the brake system follow the disassembly procedure in reverse order.
2. The brake cable should be adjusted so as to allow free rotation of the wheel.
3. Care should be taken that while assembling there should not be greases or oil on brake shoe.

Trouble shooting - Two wheeler

Trouble	Causes	Remedies
1. Poor Brakes	1. Excessive clearance between brake shoes and drum.	1. Adjust
	2. Oil or grease on brake	2. Replace oil-soaked linings
	3. Badly scored brake drums	3. Skim or Replace
	4. Binding cables & brake expanders.	4. Free up and lubricate
	5. Excessive play in wheel bearings	5. Adjust
2. Brakes dragging	1. Improper adjustment of brake linkage.	1. Adjust properly.
	2. Weak Pedal return spring	2. Replace
	3. Tight brake shoe anchoring pins	3. i) Clean and lubricate ii) Replace defective parts
	4. Improper adjustment of brake shoes	4. Adjust properly
	5. Improper adjustment of wheel bearings	5. Adjust properly
	6. No free play in brake pedel	6. Adjust.
3. Noisy brake	1. Bent or distorted back plate	1. Repair or replace
	2. Bent or distorted brake shoes	2. Replace
	3. Loose lining rivets	3. Replace
	4. Worn drums	4. Skim or Replace
	5. Improper Linings	5. Replace with genuine ones.

Precautions

1. Ensure that the linings are free from oil or grease when fitting them.
2. Wash your hands with soap and water to remove all traces of grease and solvent before handling the rubber parts of the master cylinder and wheel cylinder.
3. Be careful not to let the fluid go below level marked in the master cylinder reservior otherwise air will enter.
4. Keep all parts well lubricated with brake fluid.
5. Fluid must be added each time a wheel is bled to prevent the fluid level from dropping low enough to allow air to enter.
6. Use of gasoline, kerosene or any solvent with the slightest trace of mineral oil will damage the rubber parts.
7 Dirt is the major cause of trouble in service.
8. Ensure that the oil seals are properly fitted.
9. Bleed the air in a transparent bottle fitted with brake fluid to ensure thorough bleeding.

Evaluation

1. What are the tools required to dismantle and assemble the brakes, in two wheelers ?
2. What are the reasons for poor brakes and noisy brakes ?
3. In two wheelers what type of brake is used and how do they work ?

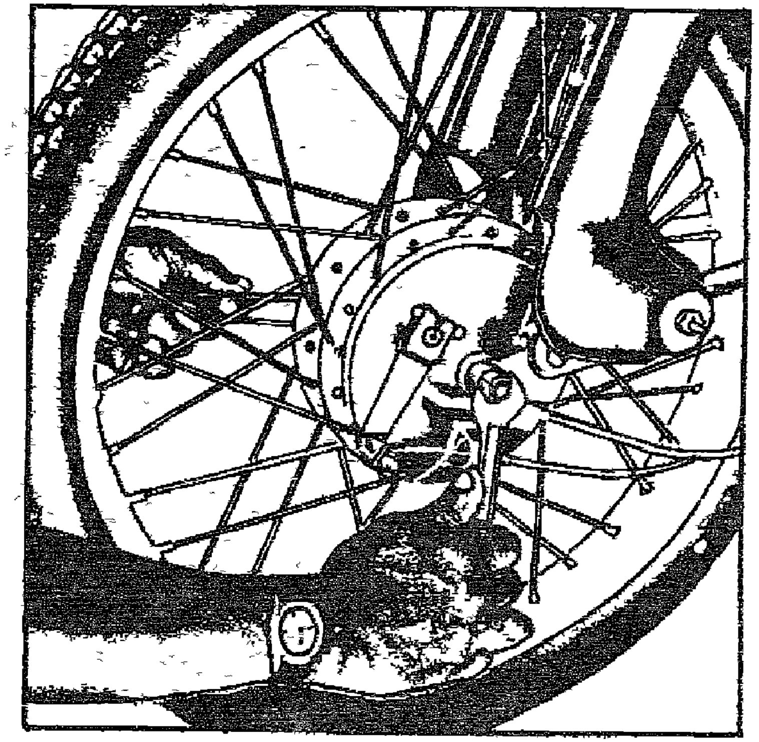


Fig 10 2 2 1 Removing the front wheel

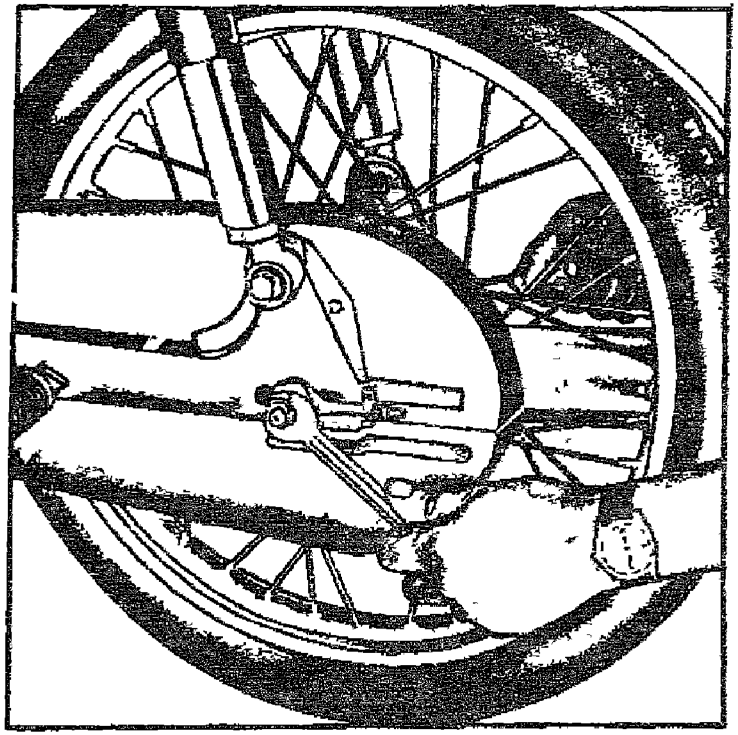


Fig 10 2 2 2 Removing the rear wheel

4. What is the procedure to be followed for brake adjustment ?

5. What do brakes do to the kinetic energy of the vehicle motion ?

6. Of what material is the brake lining made ?

Experiment No. 11.1

General Objective

Study of front End Geometry of a four wheeler.

Specifica Objective

To perform front wheel adjustment of Fiat Car.

INTRODUCTION

The steering-gear mechanism gives the driver the means of turning the front wheels of the vehicle. The mechanism consists of a steering gear box, pitman arm, drag link, tie rod, steering arms and steering knuckles which carry the front wheels.

Turning the steering wheel turns the steering shaft to which a worm gear is attached within the steering gear box. The worm gear moves roller through part of an arm. This motion is transmitted to the pitman arm, which moves back and forth across the width of the frame. Several arrangements of rods and levers are in common use but, in general, a drag link, connected to the pitman arm, transmits this movement to the tie rods connected to steering arms, turns the steering knuckles and wheels which are pivoted in the front-end support mechanism.

FRONT END GEOMETRY

The term "front-end geometry" refers to the angular relationship between the front wheels, the front wheel attaching parts, and the car frame. The angle of the king-pin from vertical, the pointing in toein or toeout of the front wheels, the tilt of the front wheels from vertical - all these are involved in front-end geometry. Every one of them influences the steering ease, steering stability and riding qualities of the car and has a direct effect on tire wear. The various factors that enter into front-end geometry are classified under the following terms. Camber, steering-axis inclination (or king pin inclination) caster, toe-in, toe-out on turns. These are discussed in detail below.

Camber Angle:

Camber is the tilting of the front wheels from the vertical. (Fig. 11.1.1.) when the tilt is outward, so that the wheels are farther apart at the top than at the bottom, the camber is called positive. When a car is running, it is carrying a certain load, due to this load the wheels get pressed from an inclined position. If there is no camber angle when the load is on the care, the wheel gets inclined inward and the negative camber takes place. Due to this, there will be more wear on the inner side of the tyre. Therfore, the wear will not be uniform on the tyre. Hence there is need to provide positive camber angle.

KING - PIN INCLINATION

(Refer. Fig 11.1.3.) The central line of the king-pin is marked. The vertical line through the central position of the king-pin is also marked. The angle between the central line of the king pin and vertical line is called the king-pin inclination. This inclination is observed while standing in front of the vehicle.

ADVANTAGES

1. It helps the car to have steering stability.
2. It helps in reducing the wear on the tyrs.

CASTER ANGLE: (Fig. 11.1.4. & 11.1.5.)

It is the angle between the king-pin axis and the vertical line when viewed from the side of the vehicle. The angle is said to be positive, if they king-pin axis is fitted backward. If it is forward, the caster is negative.

FUNCTION :

It provides straight-ahead position for the vehicle while in motion. Due to this angle the vehicle will come to straight ahead position after the turns.

(N.B. King-pin inclination also helps in bringing the straight-ahead position. It is the combined affect of both caster angle and the king-pin inclination which is considered depending upon the type of vehicle. In general, positive caster is provided on light vehicles and negative caster on heavy vehicles. And relatively, a smaller king-pin inclination is provided on light vehicles as compared to heavy vehicles)

General Values

Caster Angle (Light vehicles)	2° to 3° + ve
King-pin Inclination	7°

Heavy Vehicles

Caster Angle	10° - ve
King-pin Inclination	11°

Toe-in and Toe-out (Fig. 11.1.6.)

The toe-in ensures parallel rolling of the front wheels. It stabilises steering. It prevents side slipping and excessive wear of the tyres.

The distance at the front end between the front wheels is less than the distance between them at the rear. The front wheels point inward.

The actual amount of toe-in is only a few millimeters. The distance between the front wheels at the front end is greater than the distance between at the rear. When a car is stationary this position of the front wheels is called toe-out (Fig 11.1.6(II))

4. Equipment and tools

   a. Equipments

      1. Fiat car
      2. Turn table
      3. Gauge for castor, king pin, and camber.
      4. Toe in checking gauge (Fiat)
      5. Spirit level

   b. Tools

      1. Spanner Set (Double ended)
      2. Spanner Set (Ring)
      3. Steel scale.

Wheel Alignment

The front end geometry should be checked under full load. When proceeding with front end geometry checks and adjustments, the following sequence should be adhered to.

1. Checking of camber
2. Checking of caster
3. Checking of front wheel toe-in.

PROCEDURE:

a. Place car on level ground. Car must be fully laden

b. Place two wooden blocks having the same thickness at the turntable (or other two turntables) under rear wheels (Fig. 11.1.7)

c. Raise front wheels and rest them at center of turtables.

d. Install gauge on the wheel involved (Fig. 11.1.8) and perform the checks described below.

CHECKING CAMBER:

With Gauge anchored on wheel and scales set normally to car centerline (Fig. 11.1.8) read the value of camber angle on the camber scale which should be $0^\circ\ 30' \pm 20'$

Note: To compensate for a possible small out of true of the wheel deriving from slight differences in thickness of rim sheet, or stress warpage of the rim itself, it is advisable to repeat checking after rotating the wheel 180°. Should a different reading be had, sum the two readings and divide the resulting value by two. This will ensure correct results.

CHECKING CASTER:

Steer out wheel by 20° and bring Caster scale to 'Zero' (Fig. 11.1.9.) Steer in wheel 20° and read 'Caster' angle value on 'Caster' scale reading should be $2^\circ,\ 10'\ {}^{+10'}_{-30'}$ (Fig. 11.1.10)

ADJUSTMENTS:

Should caster and camber not comply with specified values, adjust as follows:-

Caster:

Slacken the screws securing upper swinging arm pin to sub-frame and then:

a) If Castor angle must be increased add shims in point 'B' (Fig. 11.1.11)

b) If caster angle must be reduced add in point 'A' (Fig. 11.1.11)

Camber:

Slacken the screws securing the upper swinging arm pin to sub-frame and then:-

a) If camber angle must be increased remove the same number of shims from both points 'A' and 'B' fig 11.1.11

b) If camber angle must be reduced add the same number of shims in both points 'A' and 'B' fig 11.1.11.

The addition or removal of shims in points A and B permits camber adjustments without disturbing Caster.

Checking Front Wheel Toe-in

The toe-in measurement should be checked on the wheel rims.

1. Before the check, see that:-

   a. Tyre pressures are as recommended.

      Front 22 lbs/sq in, Rear 24 lbs/sq in.

b. Wheels are in straight ahead position.

c. Steering wheel is at mid travel with spokes horizontal.

2. Adjust height of gauge C.692 plungers until they coincide with the wheel horizontal centerline then set plungers against the outer edge or rim, rear portion and mark off with chalk.

3. Next, bring gauge in front of wheels, move car forward and stop when chalk marks line up with gauge plungers. Set one plunger in contact with wheel (Fig. 11.1.12). The gap between the other plunger and the other wheel must be 1 to 3 mm, with fully laden car.

In order to take care of run out of wheels, it is desirable that toe-in be checked on wheel rims at 2 position which are at right angles to each other.

If tor-in needs correction, slacken the four clamps fixing the sleeves on track rod heads. Rotate track rods in opposite directions and by equal amount.

Note: Since track rods have one right hand and one left-hand threaded end, when turned in one direction both heads are screwed out and when turned in the opposite direction both heads are screwed in. The result of this is a varation in track rod length.

When a perfect adjustment has been obtained, tighten the four clamps. The faulty clamp must be replaced.

Evaluation Questions

1. What is 'Front-Wheel-Geometry ?
2. What is camber ?
3. What is caster ? What is its purpose ?
4. What is meant by toe-in ?
5. How do we adjust caster angle ?
6. How do we adjust camber angle ?
7. What are the effects of misalignment in front end geometry ?

/TARA/

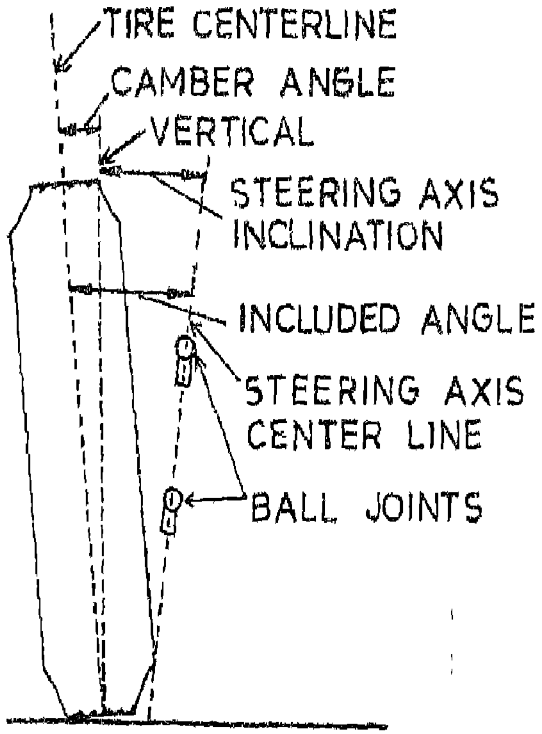
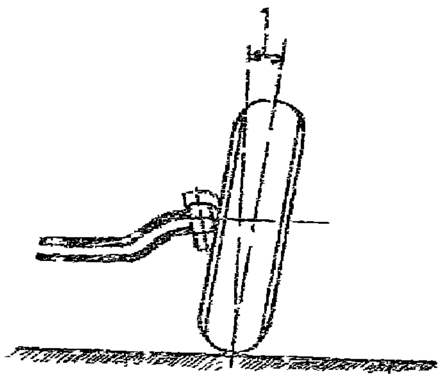


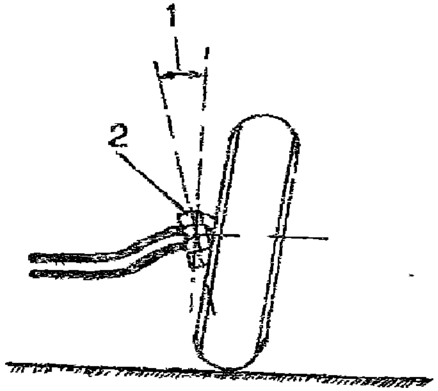
FIG. NO - 11.1.1
CAMBER ANGLE AND STEERING AXIS INCLINATION POSITIVE CAMBER IS SHOWN.

FIG:11-1 2



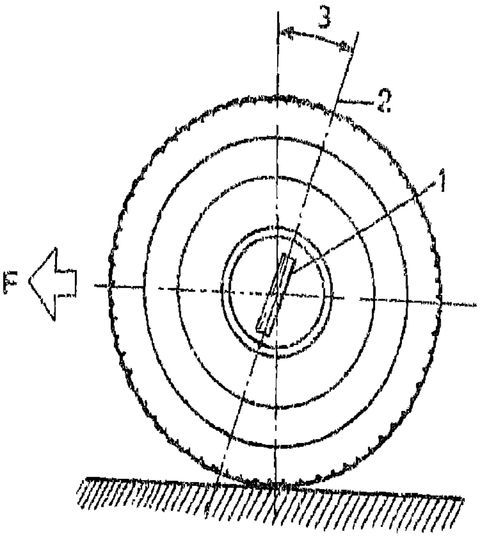
CAMBER ANGLE

FIG:11-1-3



1- KING PIN INCLINATION
2- KING PIN

FIG NO-11.1.4 POSITIVE CASTOR



F FRONTSIDE

KING PIN 2 KING PIN CENTRE LINE

3 POSITIVE CASTOR

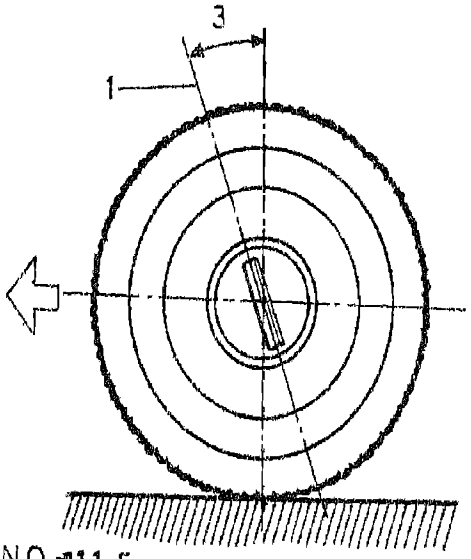


FIG NO-11.1.5
- NEGATIVE CASTOR.

F FRONT SIDE

KING PIN CENTRE LINE

NEGATIVE CASTOR.

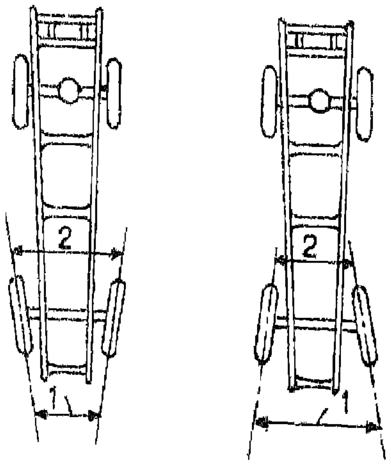


FIG NO-11.1.6

TOE IN AND TOE OUT

TOE IN SHORT DISTANCE
LONG DISTANCE

TOE OUT LONG DISTANCE
SHORT DISTANCE .

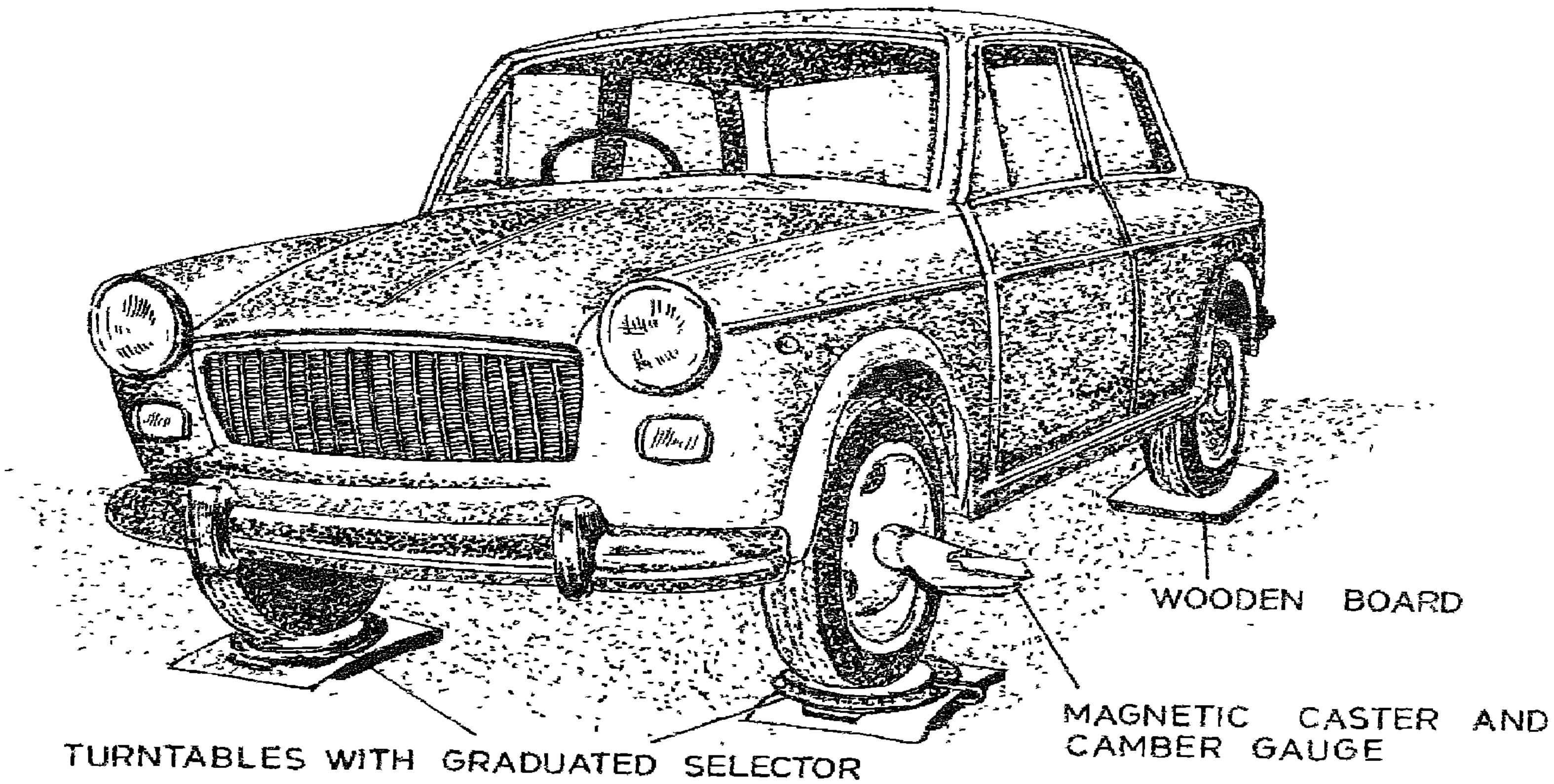

WOODEN BOARD
MAGNETIC CASTER AND CAMBER GAUGE
TURNTABLES WITH GRADUATED SELECTOR

FIG NO -11.1.7 ARRANGMENT OF THE CAR FOR CHECKING FRONT END GEOMETRY WITH MAGNETIC CASTER AND CAMBER GAUGE.

Fig. 17·1·8—Checking front wheel camber

The wheel must be in straight ahead position; graduated sector must be set at 0°. Camber scale must read 0° 30' ± 20'.

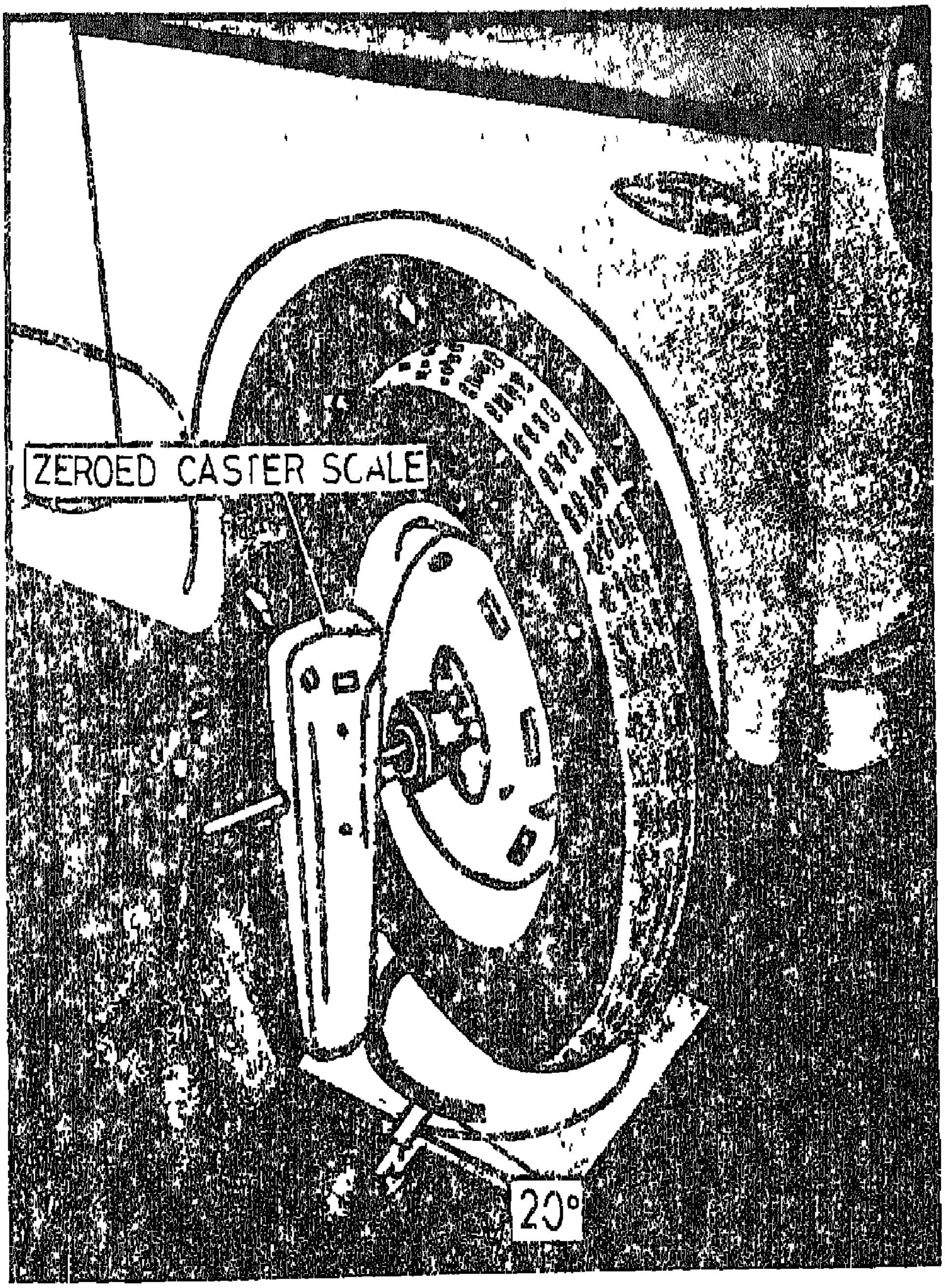


Fig. 11·1·9 – Checking front wheel caster.
1st operation : with wheel steered 20° out set "Caster" scale at zero.

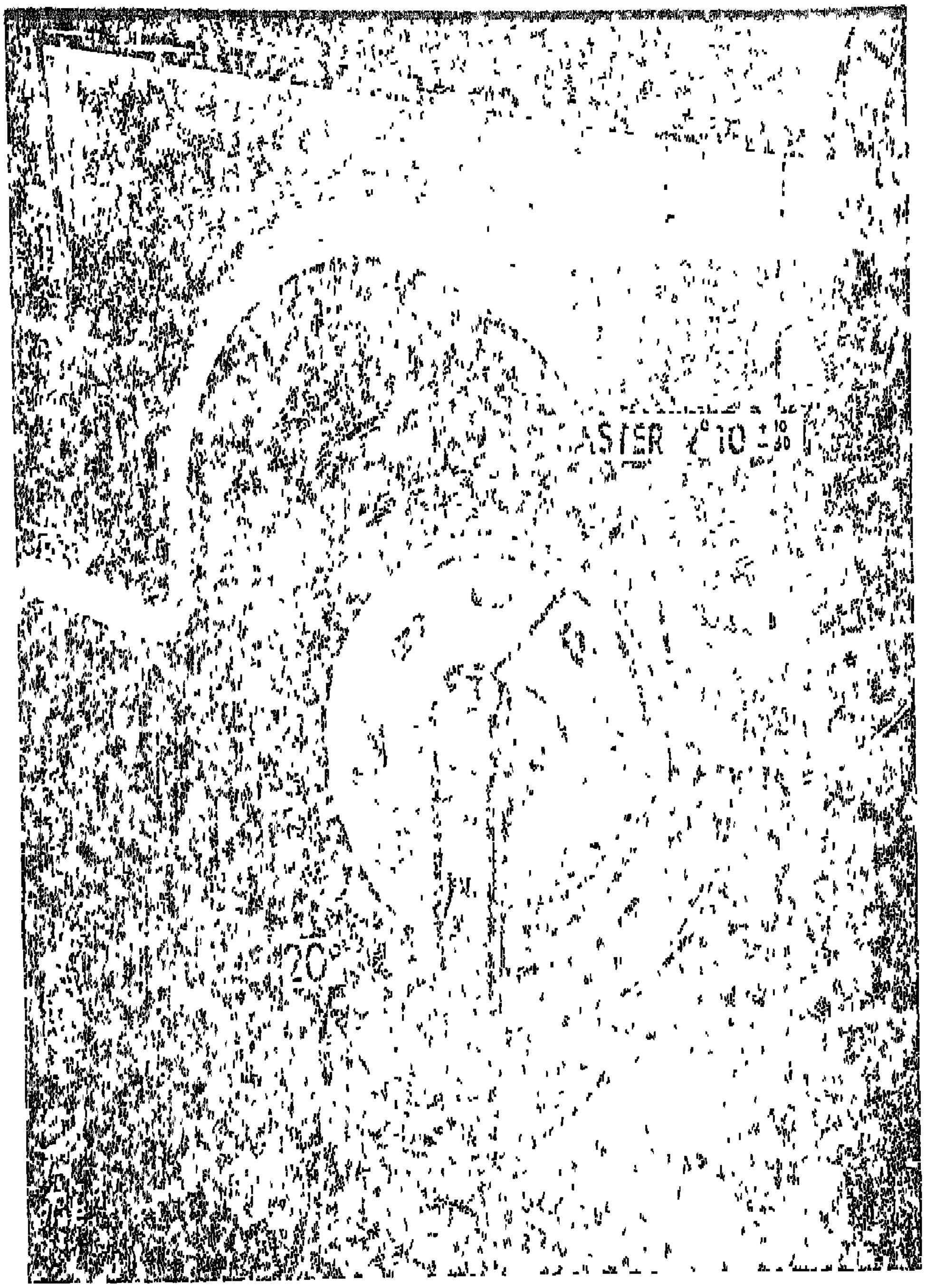


Fig. 11·1·10—Checking front wheel caster.
2nd operation : with wheel steered 20° in, the "Caster" scale must read $2^\circ 10' {}^{+10'}_{-30'}$

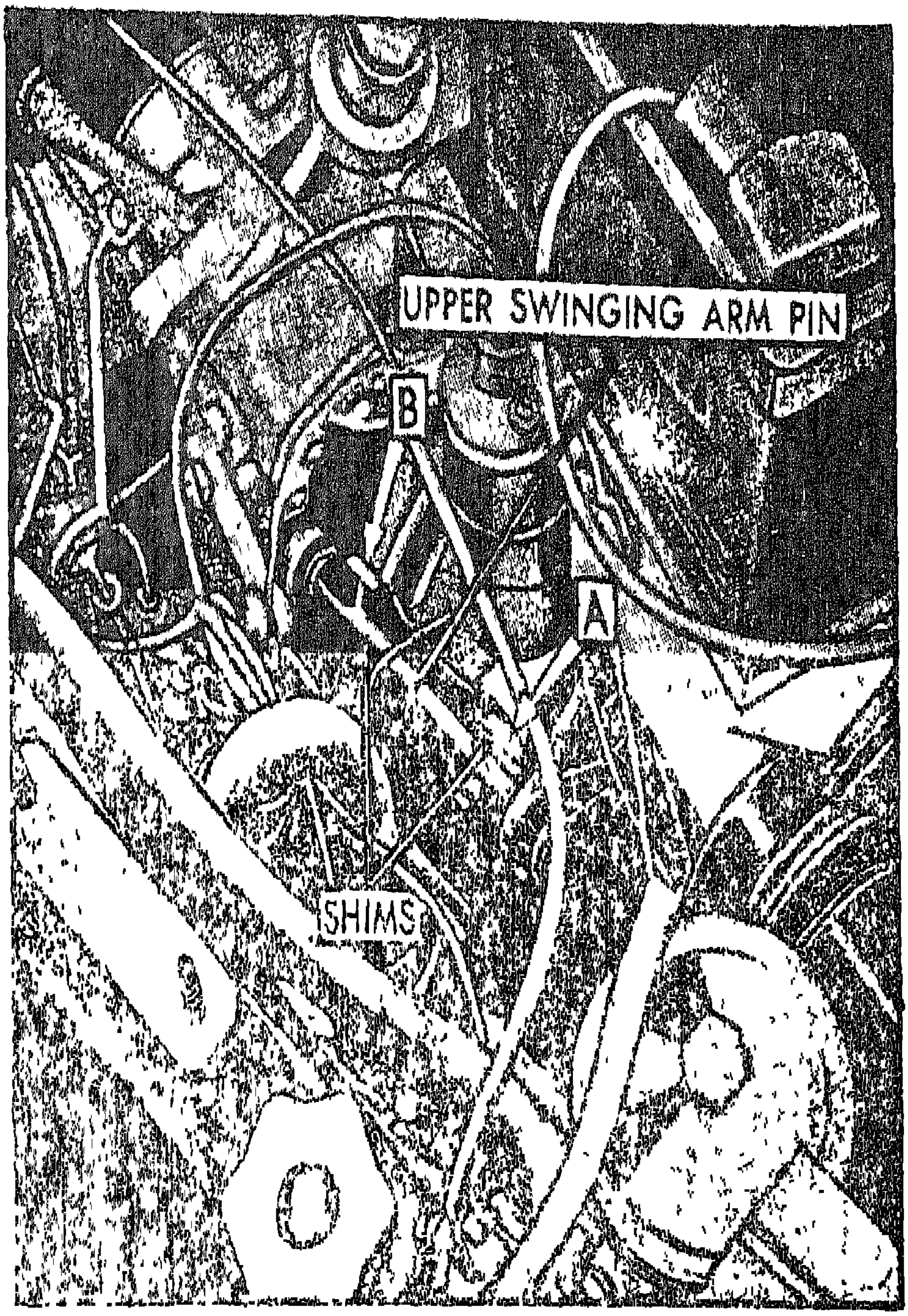


Fig. 11·1·11—Adjusting front wheel camber and caster.
A and B : points where shims are mounted.

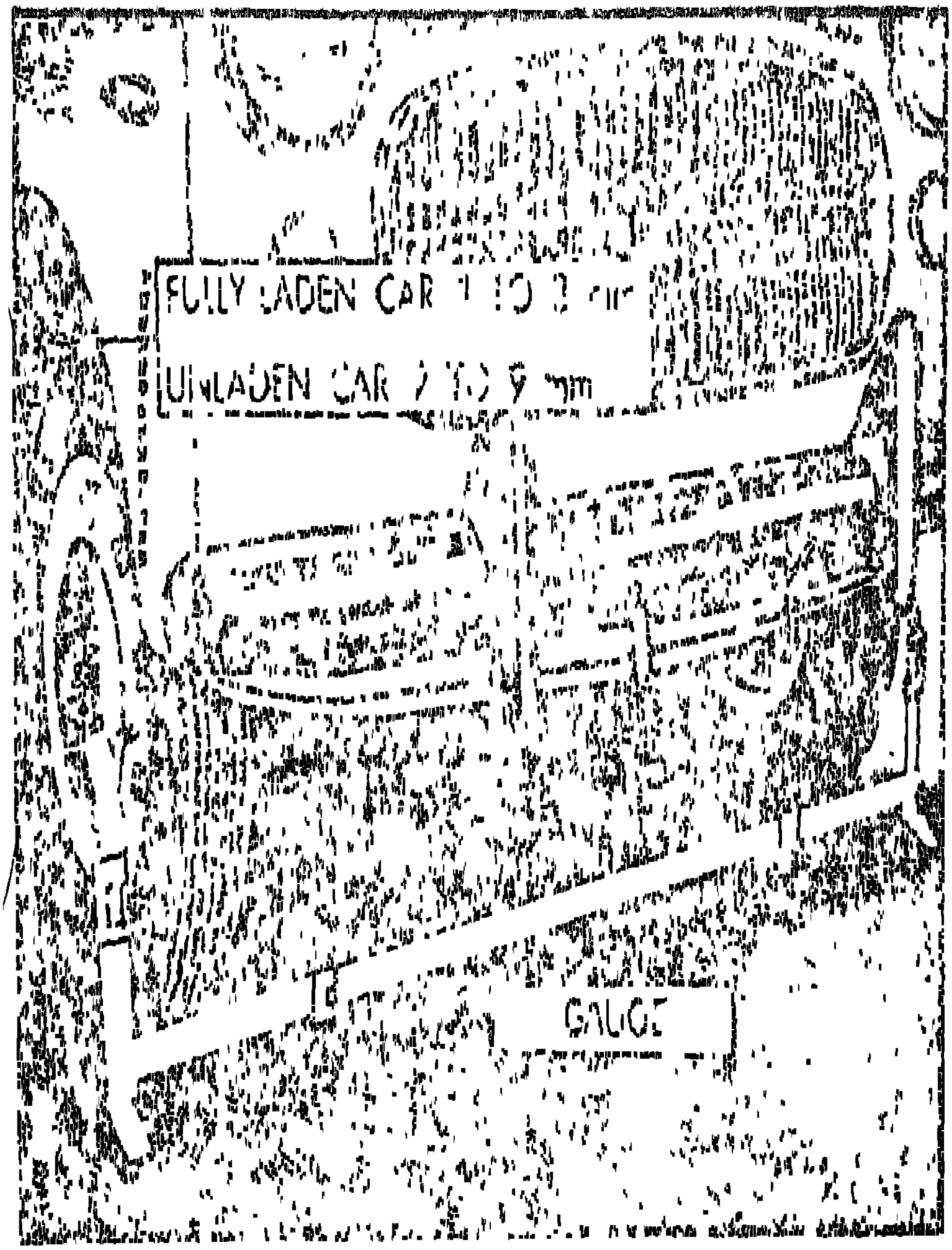


Fig.11·1·12—Checking front wheel toe-in with gauge

APPENDIX - I

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APPENDIX II

LIST OF BOOKS RECOMMENDED FOR FURTHER READING

1. Odhams Motor Manual
   Revised by Staton Abbey
   Asia Publishing House 1960

2. Internal-Combustion Engines
   by Lester C.Lichty
   Asia Students Edition
   Mc Graw Hill Book Company Inc
   and Kogakusha Company Ltd. 1951

3. Automotive Engines Maintenance and Repairs
   by Ernest Venk and Walter Billiet
   D.B. Taraporewala and Sons Co.Pvt.Ltd.,
   Bombay.

4. Heat Engines
   by Patel, Karamchandani
   Vol.I & II, Acharya Book Depot
   Vadodara.

5. Scooter Maintenance complete
   by Jan Stevens
   Constable and Co., London.

6. The Second Book of Vespa
   by J. Thorpe
   Pitman Publishing.

7. The Second Book of Lambretta
   by R.H. Warring
   Pitman Publishing.

8. Workshop Technology
   by W.A.J. Chapman
   Vol. I
   The English Language Society and Edward
   Arnold (Publishers) Ltd. (ELBS)

9. A first year Engineering Drawing
   by A.C. Parkinson

   Sir Isac Pitman and Sons Ltd.

10. Intermediate Engineering Drawing,
    by A.C, Parkinson.

11. I.S.I. Code of Practice,for General
    Engineering Drawing - 696 - 1972.

12. Service Manuals from different manufacturers
    of two wheel vehicles and four wheel vehicles (cars)

APPENDIX IV

Questionnaire for Collecting Opinion of

Teachers and Pupils

on the

Laboratory Manual

on

Automobile Servicing and Maintenance

Vocationalization of Education Unit
National Council of Educational Research & Training
Sri Aurobindo Marg, New Delhi - 110016.

1983

Dear Teacher/Pupil,

We are happy to place this Laboratory Manual at your disposal with the hope that it will help you conduct some of the practical works prescribed in the syllabus or practices necessary to gain thorough vocational expertise.

The Manual does not conform to the syllabus of any particular state but includes most of the important activities common in syllabi of different states. This is an experimental edition with ample scope for further improvement through feed-back from you. We solicit your active cooperation for the improvement of the Manual.

After having used the Manual for a year or more, kindly read the appended questionnaire carefully and write down the answers precisely and exactly to the point. Kindly use additional sheet of paper if the space provided for is insufficient. The questionnaire may be mailed at the following address :-

Mr. A.P. Verma
Programme Coordinator
Vocationalization of Education Unit
National Council of Educational
Research and Training
Sri Aurobindo Marg
New Delhi - 110016.

QUESTIONNAIRE FOR THE TEACHERS

LABORATORY MANUAL ON ____________________

A. Name of the Teacher (In Block Letters) ____________________

B. Name and Postal Address of the Institution ____________________

____

____

C. I) Qualification ____________________

II) Teaching Experience ____________________

III) Professional/Field/Industrial experience ____________________

1. Do the experimental activities covered in the Manual develop desired skills in the students ?

Yes/No

6. a) Does the relevant information given under every experimental activity furnish enough theoretical back ground of the activity.

Yes/No

b) If not, list the experiments where relevant information needs further modification.

Experiment No	Portion	Type of modification needed

7. a) Does the relevant information contain any factual errors or inaccuracies ?

Yes/No

b) If any, give details

Experiment No	Error/Inaccuracy	Should read as

8. Did you come across any expressions/sentences in the Manual which do not carry precise meaning or information ? If Yes, then give the details.

Page No.	Expression/Sentence	Would be more appropriate

9. Are the instructional objectives pertaining to each experimental activity rational ? If not, list down the irrational, irrelevant or vague ones.

xperiment No.	Irrational/Vague Objectives

10. Does accomplishment of the experiments result in realisation of the objectives.

Yes/No

11. Could you suggest any improvement in the presentation of the experiments along with your observations?

Experiment No	Observations

12. Are the illustrations adequate ?

Yes/No

13. Are there any inaccuracies in the illustrations/ diagrammes given in the Manual ? If yes please point them out.

Illustration No	Discrepancy/Inaccuracy

14. Please give your overall opinion about the Manual which may be useful in the effective improvement of the future editions.

QUESTIONNAIRE FOR THE STUDENTS.

LABORATORY MANUAL ON ____________________

A. Name of the Student ____________________
(In Block letters)

B. Name and address of ____________________
the school/college
____

C. Class ____________________

D. Medium of Instruction ____________________

1. List out the portions of the manual which you found difficult to understand and give reasons.

Experiment No.	Portion of the Text	Difficulty experienced

2. Mention the places where you found the language difficult to understand

Experiment No.	Page No.	Difficulty experienced

3. Point out the figures/illustrations which do not help in under standing the topic/theme.

Illustration No.	your observations/Difficulty experienced

4. Can you conduct the experiments your self with the help of this manual

Yes/No

If not, point out the portions of activity units which need further elaboration or explanation.

Experiment No	Portion to be elaborated

5. Was thetheoretical portion given in the Manual useful to you in understanding the why of the experiment ?

Yes/No.

6. Do you now understand the scientific reasons behind the steps you have taken in conducting various experiments ?

7. Yours overall candid opinion about the Manual